

## CHIA - SMOKY HOLLOW

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### CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)

Proposed Smoky Hollow Mine  
Andalex Resources, Inc., Tower Division  
PRO/025/002  
Kane County, Utah

October 3, 1995

Andalex Resources, Inc.'s proposed Smoky Hollow Mine is located in the southern Kaiparowits Plateau Coal Field, approximately 15 miles north-northeast of Big Water, Utah, 11 miles north of Lake Powell, and 25 miles north of Page, Arizona (Figure 1). Access to the area is by dirt road from Big Water. A section of this road passes through Glen Canyon National Recreation Area. The proposed mine portals will be located in Smoky Hollow, a side canyon of Warm Creek Canyon. (Squaw Canyon, situated just to the east of Smoky Hollow, is identified as Smoky Hollow on some older maps. There is another drainage named Smoky Hollow that drains eastward into Last Chance Canyon and is located just east of the Andalex permit area.) Warm Creek discharges into Lake Powell at Warm Creek Bay. The United States Bureau of Land Management (BLM) refers to the proposed Smoky Hollow Mine as the Warm Creek Project.

The Smoky Hollow Mine permit area is shown on Figures 2 and 3. In addition to the coal leases within the Smoky Hollow Mine permit, Andalex Resources has leases immediately to the north, west, and east for possible future mining within what is called the Logical Mining Permit Area (LMPA). Andalex has leases on additional coal north and east of the LMPA, but there are no current plans to mine this coal and these leases will probably be dropped in the near future. There are no active mines in the area, but 5M, Inc. has leases to the north of the Andalex leases that are subject to diligent development. Figure 2 shows the other anticipated operations in relation to the Smoky Hollow Mine permit area. Portions of both the Andalex and 5M leases are within BLM wilderness study areas. Farther to the north leases have been issued to Utah Power and Light Company (UP&L), but they are in suspension because they are in a BLM wilderness study area and have not been included in this Cumulative Hydrologic Impact Assessment (CHIA). Sunoco has a Preference Right Lease Application on coal adjacent to the UP&L leases.

This CHIA is a findings document involving an assessment of the cumulative impact of all anticipated coal mining operations on the hydrologic balance within the Cumulative Impact Area (CIA). The CHIA is not simply a determination if coal mining operations are each designed to prevent material damage beyond their respective permit boundaries when considered

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individually, but rather is a determination if there will be material damage resulting from effects that become cumulative outside the individual permit boundaries.

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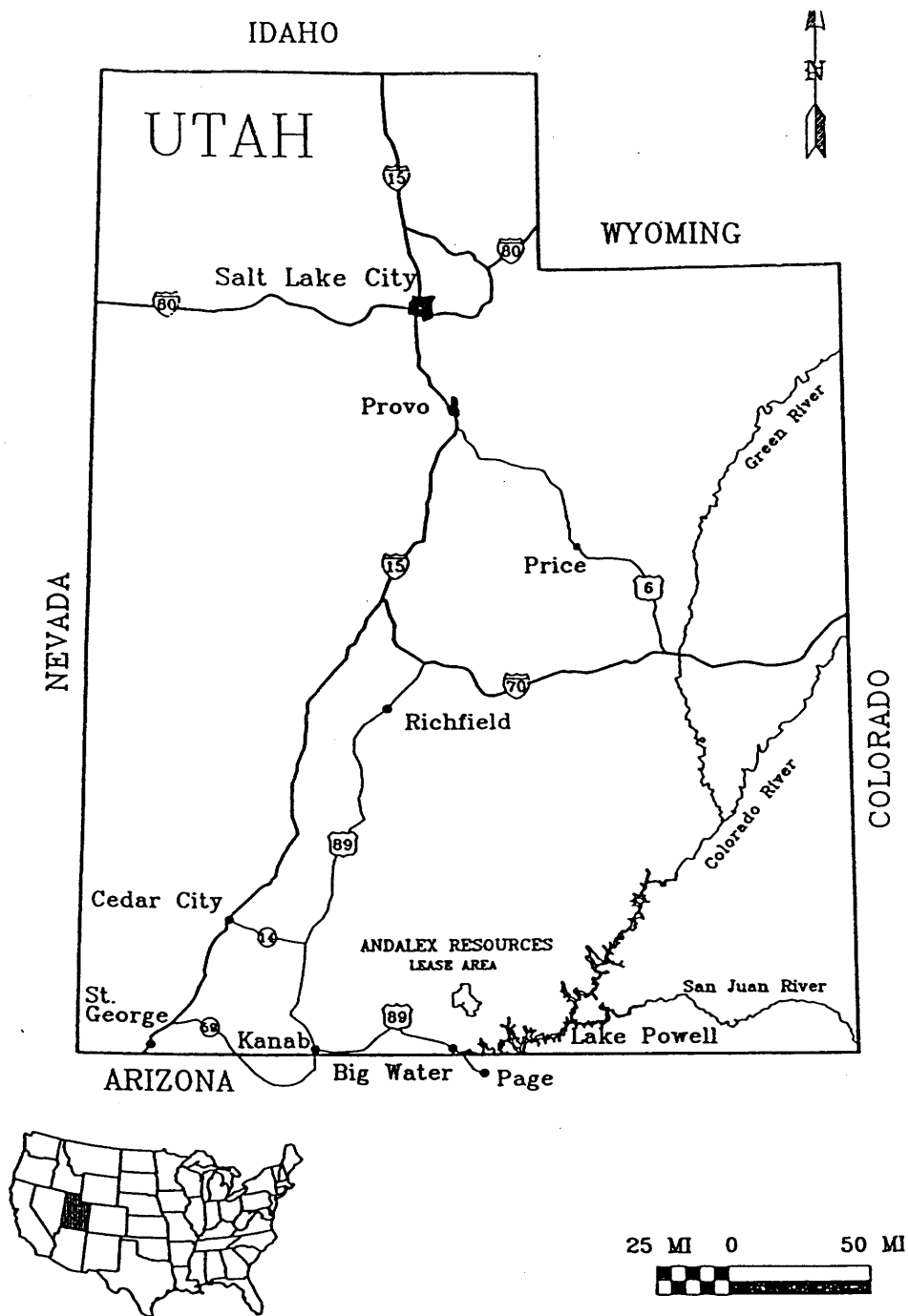


Figure 1 - Location of Proposed Mine (Figure 1 of Andalex, 1994)

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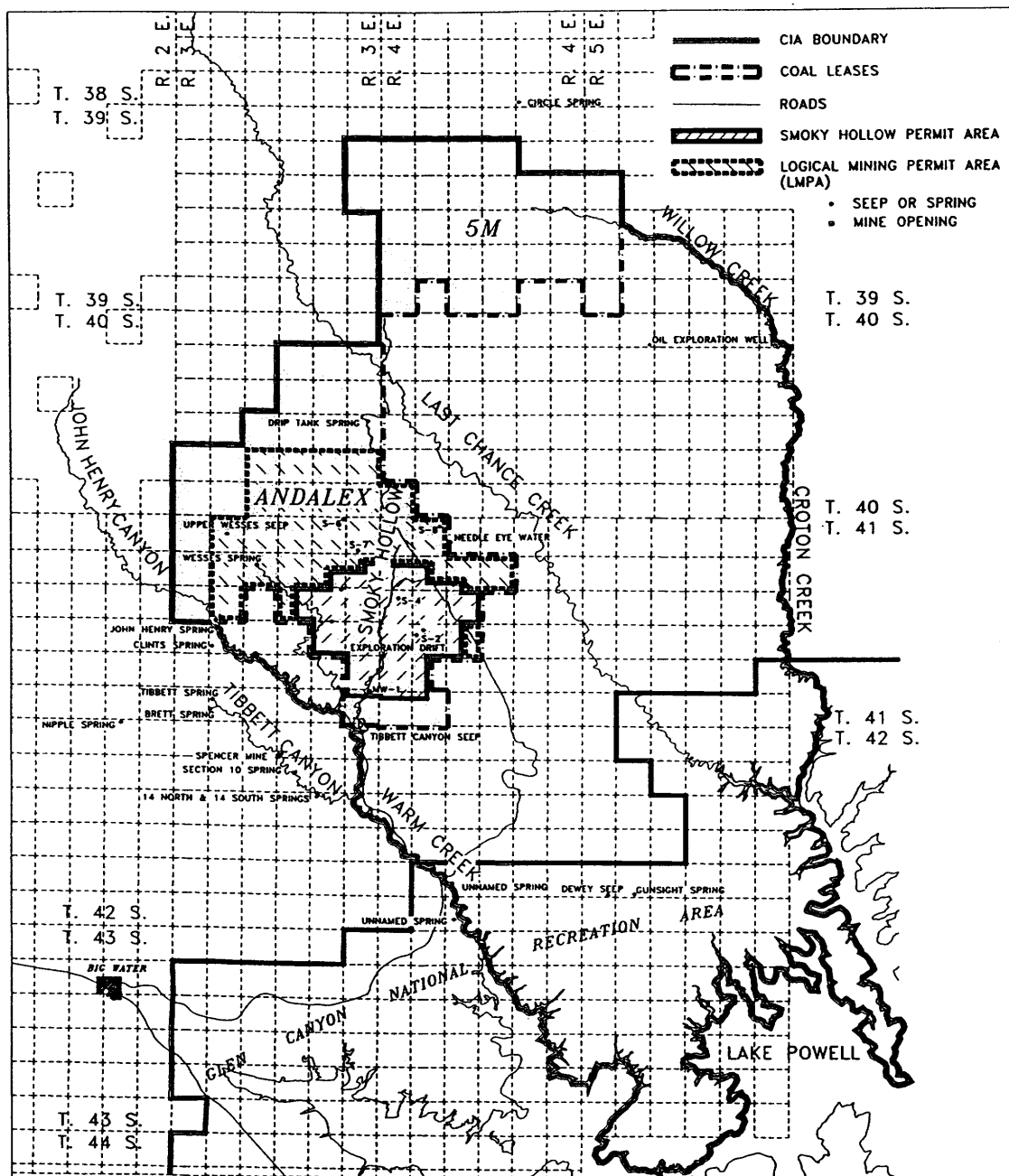


FIGURE 2 Cumulative Impact Area (CIA)

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The objectives of a CHIA document are to:

1. Identify the Cumulative Impact Area (CIA).
2. Describe the hydrologic system.
3. Document the baseline conditions of surface and ground water quality and quantity.
4. Identify which hydrologic resources are likely to be impacted and determine which parameters are important for predicting future impacts to those hydrologic systems.
5. Identify relevant standards against which predicted impacts can be compared.
6. Estimate probable future impacts of mining activity with respect to the parameters identified in 4.
7. Assess probable material damage.
8. Make a statement of findings.

Material damage is not defined in either the Utah or Federal regulations. Criteria that are used to determine material damage to hydrologic resources in coal mining programs administered by other states or by the Federal Office of Surface Mining (OSM) include:

- Actual or potential violation of water quality criteria established federal, state, or local jurisdictions.
- Changes to the hydrologic balance that would significantly affect actual or potential uses as designated by the regulatory authority.
- Reduction, loss, impairment, or preclusion of the utility of the resource to an existing or potential water user.
- Short term (completion of reclamation and bond release) impairment of actual water uses that cannot be mitigated.
- Significant actual or potential degradation of quantity or quality of surface water or important regional aquifers.

This CHIA has been prepared by the Utah Division of Oil, Gas, and Mining. It complies with federal and Utah coal regulations as found in 30 CFR 784.14(f) and

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R645-301-729 respectively. Sources of information used to prepare this CHIA are listed in the References section. Sources include the Kaiparowits Final Environmental Impact Statement (EIS) prepared by the BLM in 1976 and the Smoky Hollow and Logical Mining Permit Area (LMPA) Permit Application Packages (PAP's) submitted by Andalex Resources, Inc. to the Utah Division of Oil, Gas, and Mining (DOGM). Information provided in these two documents is often from other sources, most of which are not directly referenced in this CHIA. Additional information has been provided by Andalex in the Logical Mining Permit Area Permit Application Package submitted to DOGM on December 14, 1994.

### I. CUMULATIVE IMPACT AREA (CIA)

The Cumulative Impact Area (CIA) is shown on Figure 2. This is the area within which the actual and anticipated coal mining activities may interact to affect the surface and ground water. The CIA is determined based on anticipated mining activities, knowledge of surface and ground water resources, and anticipated impacts of mining on those water resources. Both surface and ground water CIA's have been delineated.

The Spencer Mine was operated in Tibbett Canyon from 1910 to 1913 (Figure 3), but there are no active coal mine operations within the CIA. Mono Power proposed a group of five underground coal mines in the Smoky Hollow area that were to have produced up to 12 million tons of coal per year (USGS, 1979). Anticipated mining operations that have been included within the CIA are the proposed Smoky Hollow Mine, adjacent coal leases held by Andalex, and the 5M, Inc. coal leases. The upstream CIA boundary coincides with the lease boundaries. Downstream the CIA extends to Lake Powell, a multipurpose storage reservoir with usable storage capacity of about 33 million acre feet. Hydrologic impacts should not become cumulative or produce material damage within the lake because of dilution that will occur.

Several coal outcrops in Smoky Hollow were exposed by exploration in the 1960's and portals of a test mine were opened in 1971. These areas have been backfilled and graded, and most of the area disturbed by these operations will be assimilated in the Smoky Hollow Mine reclamation. Existing hydrologic impacts from these operations are incorporated into the baseline information.

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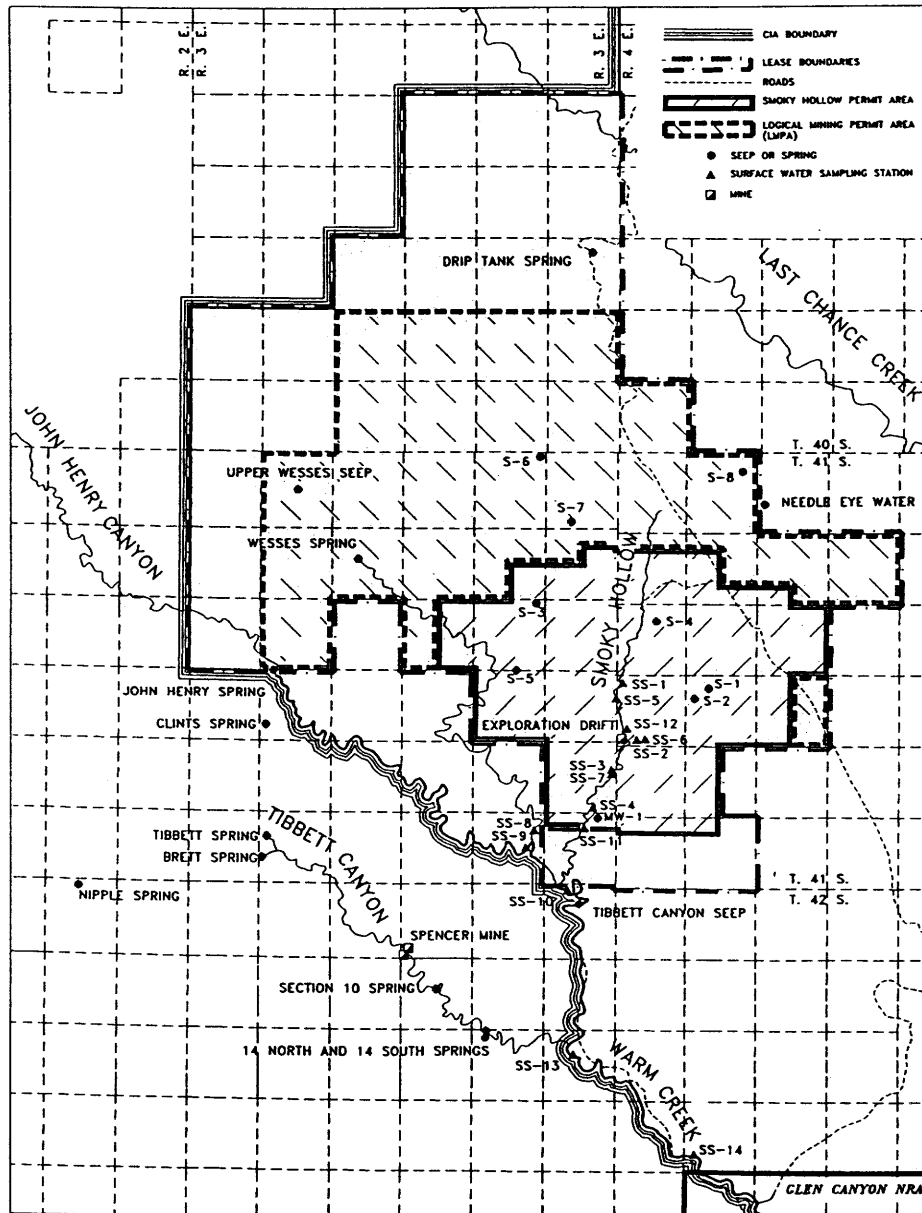


FIGURE 3 Smoky Hollow Permit Area and LMPA

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The Colorado River and Lake Powell are the primary sources of surface water in the area around the southern Kaiparowits Plateau. Streams in the permit area flow only in response to heavy rainfall or snowmelt.

A ground water CIA should include the area between the anticipated mining operations and the aquifer discharge points. In the southern Kaiparowits Plateau, perched aquifers are typically shallow and receive recharge from relatively small areas near where they discharge as seeps and springs. The seeps and springs included in this CHIA are treated as an aggregate in a single ground water CIA that coincides with the surface water CIA. Several springs that are monitored by Andalex and are included in the following discussions have been left out of the CIA because they and their recharge areas are isolated from the anticipated coal mining operations by geologic structure or by deeply incised surface drainages.

There is no evidence of a regional aquifer within the potentially impacted strata above or below the coal seams. The Calico Sandstone at the base of the John Henry Member is continuous over a large area, but permeabilities are low, similar to those of other sandstones of the Straight Cliffs Formation. The coal bearing strata are separated from underlying, more permeable sandstones by six to seven hundred feet of low permeability Tropic Shale. Of these deeper sandstones, the Navajo Sandstone aquifer has the greatest potential for ground water development (Blanchard, 1986). The Navajo aquifer is recharged in distant areas to the north, west, and southwest, far beyond potential impacts from the proposed mine. It discharges to the south directly into Lake Powell.

## II. HYDROLOGIC SYSTEM

### Precipitation

The closest operating weather station to the permit area is located in Page, Arizona. There is a National Weather Service monitoring station at Big Water, Utah which records temperature and precipitation on a daily basis. The BLM operates several rain gauges around the Nipple Bench area. Andalex has established several locations within the permit area for recording precipitation data. Precipitation information was collected in the area from 1971 to 1974 as part of a Brigham Young University study.

The annual precipitation at Page, Arizona from 1967 to 1982 averaged 6.35 inches/year. Seasonal averages for the same years at Page, Arizona were: March to May - 1.48 inches/year; June to August - 1.31 inches/ year; September to November - 1.83 inches/ year; and December to February - 1.75 inches/year.



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Brigham Young University (BYU) collected precipitation information from five locations between the proposed mine and Lake Powell from 1971 through 1974. Precipitation ranged from 3.94 to 15.12 inches/year and averaged 7.31 inches/year. A higher percentage of the yearly precipitation usually occurred during the cooler months of October through March than during the warmer months of April through September. The lowest percentage of yearly precipitation typically occurred from April through June.

Snowmelt is a major contributor to streamflow in the region. Snow is generally stored through most of the winter at higher altitudes and gradually melts during the spring and early summer. The potential ground water recharge for the drainages in the Kaiparowits Plateau is estimated to be only 1 gpm/mi<sup>2</sup>.

### Surface Water

Streams within the area of the proposed Smoky Hollow Mine flow only in response to heavy rainfall or snowmelt. Summer precipitation is received in the form of intense, localized thunderstorms. Intense rainfall may cause flooding at times but the areas affected are usually small and well drained. Runoff tends to be rapid and of short duration and carries a very high level of suspended solids. The magnitude of the 100 year, 6 hour precipitation event ranges from 2 inches near Lake Powell to 3 inches in the higher elevations. Streams are of little value as water supplies because they are dry much of the year.

The Colorado River and Lake Powell are the primary sources of surface water in the southern Kaiparowits Plateau area. The Glen Canyon Dam impounds a section of the Colorado River to form Lake Powell, located approximately 11 miles south of the proposed Smoky Hollow Mine. Lake Powell is a multipurpose storage reservoir that has inundated the southeastern edge of the Kaiparowits Plateau. Usable storage capacity, including bank storage, is about 33 million acre feet.

### Ground Water

Ground water occurs in the Straight Cliffs Formation in small, localized perched systems related to discontinuous sandstone lenses and also thin continuous sandstones such as the Tibbett Canyon Member. Continuous regional aquifers are found in deeper formations such as the Navajo Sandstone, separated from the coal bearing strata by 600 to 700 feet of low permeability Tropic Shale and additional thicknesses of other low permeability strata. A principal factor influencing the distribution and availability of ground water is geology.

### *Geology*

#### *Stratigraphy*

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Where exposed, the Navajo Sandstone is a recognizable cliff-former, strongly jointed, and composed mostly of a fine-grained sandstone with aeolian cross-bedding. It is generally a light colored, fine- to medium-grained friable and massive sandstone that is weakly cemented with carbonate and iron oxide. It intertongues with the overlying Carmel Formation. It is estimated to be 1,100 to 1,700 feet thick beneath Smoky Hollow. The principal regional aquifer beneath the permit and adjacent areas exists in the Navajo Sandstone (Blanchard, 1986). Beneath the proposed permit area the potentiometric surface may rise to within several hundred feet of the lowest coal seam to be mined, even though the aquifer is at a depth of 1,000 feet or more. Several wells tap the Navajo where it lies at or near the land surface around the margins of the Kaiparowits Plateau, and large diameter wells can yield up to 1,000 gallons per minute.

The Carmel overlies the Navajo Sandstone and consists of interbedded shale, sandstone, limestone and gypsum. It is mainly a reddish brown very fine- to coarse-grained quartzose sandstone and pale reddish brown to grayish red mudstone. The thickness ranges from 80 to 520 feet. Ground water in the Navajo aquifer can become more saline in areas where the potentiometric surface rises and water contacts the Carmel Formation.

The orange to reddish color and massive appearance make the Entrada Formation conspicuous in outcrops. It is mostly fine-grained sandstone with lesser amounts of reddish shale. Thickness of the unit ranges from 200 to 900 feet.

The Jurassic Cow Springs Sandstone and overlying Morrison Formation are cliff forming sandstones that contain conglomerates and shale. The unconformable contact with the underlying Jurassic rocks is sharp. A regional unconformity separates the Cow Springs and Morrison from the overlying Cretaceous strata and truncates these two formations near Wahweap Creek. Maximum combined thickness in the Kaiparowits Plateau could be as much as 700 feet, but thickness beneath the CIA is not known.

The Dakota Formation is the oldest Cretaceous unit exposed in the southern Kaiparowits Plateau area. The ledge-forming Dakota is sandstone interbedded with mudstone and varying amounts of conglomerate, claystone, bentonite and coal. It is up to 250 feet thick.

The Tropic Shale is a thinly laminated to thin-bedded mudstone and shale unit with lesser amounts of sandstone, bentonitic claystone, siltstone, and limestone. It is 610 to 705 feet thick in the area of the CIA. It has low permeability and hinders vertical movement of ground water. The Tropic Shale is the principal aquiclude separating the overlying coal bearing strata of the lower Straight Cliffs Formation from the Navajo Sandstone.

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The Straight Cliffs Formation is locally divided into four members, from oldest to youngest: the Tibbett Canyon, Smoky Hollow, John Henry, and Drip Tank Members. Exploratory drill-hole data reveal discontinuous, perched saturated zones in and above the coal-bearing beds. Recharge to these perched zones is limited because they are enveloped by low permeability mudstones. Horizontal and vertical hydraulic conductivity analyses of six siltstone samples ranged from  $1.3 \times 10^{-7}$  to  $1.1 \times 10^{-4}$  ft/day. X-ray diffraction analyses of mudstone showed smectites comprise a major portion of the clay minerals.

The Tibbett Canyon Member is characteristically a littoral sandstone with gray mudstone and siltstone partings dividing the sandstone beds. It is cliff forming and ranges in thickness from 70 to 185 feet in the Smoky Hollow area. Regional transmissivities of the Tibbett Canyon Member and Calico Sandstone are estimated to be similar. Data regarding the occurrence of ground water within the Tibbett Canyon Member are not available; however, it is reasonable to assume that the Tibbett Canyon Member fits the pattern of the Straight Cliffs Formation. Tibbett Canyon Seep is located in Warm Creek Canyon approximately one mile south of the Smoky Hollow permit boundary. Springs 14 South and 14 North issue from the Tibbett Canyon Member in Tibbett Canyon, a side canyon to Warm Springs Canyon. Ground water monitoring well MW-1 was installed in the Tibbett Canyon Member in 1990 and is located roughly midway between the mine and Tibbett Canyon Seep (Figure 3). The relatively impermeable Tropic Shale beneath the Tibbett Canyon Member probably promotes saturation of the member in structural troughs.

The Smoky Hollow Member of the Straight Cliffs Formation has three informal subdivisions: a basal coal zone, a middle barren zone, and the Calico Sandstone at the top. The coal zone contains dark gray carbonaceous mudstone, thin coal beds, and very thin-bedded sandstone. The barren zone consists of yellowish gray to white sandstone beds and gray shale or mudstone. Some of the mudstones are bentonitic.

The Calico Sandstone, which intertongues with the upper beds of the barren zone, consists of fine to coarse grained, poorly sorted, occasionally pebbly sandstone. This sandstone, which lies approximately 150 feet below the Red coal seam, averages 25 feet in thickness and attains a maximum thickness of 51 feet. The top of the Calico Sandstone represents a regional unconformity and the bed itself is missing near Wahweap Creek about 3 miles east-southeast of Big Water. The Calico Sandstone was also eroded from the northeastern part of the region prior to the deposition of the John Henry Member. There are no known water supply wells in the Calico Sandstone or the other units of the Smoky Hollow Member.

The John Henry Member is a slope- and ledge-forming unit of sandstone, mudstone, carbonaceous mudstone, and coal. The coal seam to be mined at Smoky

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Hollow, the Red seam, is in the John Henry Member. Mudstone interbeds with the sandstones of the barren zones above and below the coal seam. Ground water was encountered in exploratory drill holes in discontinuous perched zones within the John Henry Member. Only Section 10 Spring occurs in the John Henry Member.

The Drip Tank member is mostly yellow brown to yellow gray, fine to medium grained, poorly sorted, lenticular sandstone in medium to thick beds. The sandstone is interlensed with minor mudstone and pebble conglomerate. Discontinuous ground water zones support the flow to a limited number of seeps and springs within the region. Discharge from individual springs is generally less than 1 to about 20 gallons per minute. Seeps S-1 through S-8, Needle Eye, Drip Tank, John Henry, Clint, Wesses, and Tibbett Springs issue from the Drip Tank Member. Regionally, the Drip Tank Member is considered a major water bearing unit of the Straight Cliffs Formation (Plantz, 1985), but locally it is discontinuous and deeply incised by canyons and contains limited water resources.

The Wahweap Formation, an interbedded sandstone-mudstone unit, conformably overlies the Straight Cliffs Formation and crops out over the northern part of the CIA. Plantz (1985) indicated that discharge from seeps and springs in the Wahweap is from less than 1 to about 5 gpm. Andalex' surveys located only one seep, Upper Wesses Seep, in the Wahweap Formation. Seepage was observed near the base of the Wahweap Formation beneath the base of a sandstone ledge underlain by fine-grained sediments. Total seepage at this site was less than 0.5 gpm. None of the exploratory drill holes encountered ground water in the Wahweap Formation.

Thin alluvial deposits of clay, silt, and sand are found in the canyon bottoms. Landslides are located along canyon sides and Tropic Shale outcrops. Poorly stratified gravel, sand, and clay deposits form terraces and the dissected remnants of erosional terraces in the southern parts of the CIA. Wind blown sand is found on benches and pediment surfaces.

### *Structure*

Overall, the Kaiparowits Plateau is a structural basin, with the basin center located approximately 15 miles northwest of the proposed Smoky Hollow Mine. The northeast side of the basin is Fiftymile Mountain and the west side is the East Kaibab monocline. The Paunsaugunt Fault terminates the basin on the north, and the Colorado River has eroded Glen Canyon down through the south side of the basin. Surface drainage is to the southeast, toward Glen Canyon. Internal structure of the basin is characterized by asymmetric synclines and anticlines. Most of these folds plunge toward the basin center, with fold axes typically oriented north-south to northwest-southeast. A few anticlines, Smoky Hollow anticline being one, are double plunging. Faults are normal and often parallel to the fold axes, but they are not

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major structural features. Throws are generally small, 200 feet being the largest noted by Doelling and Graham (1972).

The proposed Smoky Hollow Mine is near the crest of the Smoky Mountain anticline, which plunges to the northwest at about 2 degrees, against the regional drainage. Dip on the west flank of the anticline is approximately 2 to 3 degrees to the southwest, and on the east flank it is 2 to 8 degrees to the northeast. Smoky Mountain coincides with the crest of the Smoky Hollow anticline. Last Chance Canyon, east of the mountain, coincides with the Last Chance syncline. Sections of Warm Creek, Tibbett, and Wesses Canyons follow the more sinuous Warm Creek syncline on the west flank of Smoky Mountain. Based on information from drilling, ground water flow appears to be diverted around the north plunging nose of the Smoky Hollow anticline and into the Warm Creek and Last Chance Synclines.

### *Seeps and Springs*

Andalex initially identified and observed eight seeps and springs in the Smoky Hollow area and began baseline sampling and analysis in 1988. Andalex had spring and seep surveys conducted in and around the Smoky Hollow Mine permit area in September 1990 and February 1992. The September 1990 survey located five seeps or damp areas in an area that extended at least one-quarter mile beyond the boundary of the proposed Smoky Hollow permit area. The February 1992 survey included the eight previously known seeps and springs, the five seeps located in the September 1990 survey, plus two additional springs identified from a U.S. Geological Survey (USGS) topographic map. Wesses Spring was added to the list of monitored sites in 1993. During November 1994 and April 1995 additional survey work was performed within the LMPA and at least one-half mile to the north and west beyond the LMPA boundary. The November 1994 survey located 4 additional seeps within the LMPA, but no additional seeps or springs were found in adjacent areas. No additional sites were found during the April 1995 field work. Locations of the seeps and springs are shown on Figures 2 and 3. Several seeps and springs that were not included in the Andalex surveys but that are within or adjacent to the CIA have been identified from USGS topographic quadrangles and are also shown on Figure 2.

Section 10 Spring (Figure 2), located in Section 10, T. 42 S., R. 3 E. (Tibbett Bench 7 1/2 minute topographic quadrangle) was visited by Andalex in October 1988, September 1990, and in February 1992. No water, moist soil, efflorescence, alkali deposits, trees, unusual vegetation, or signs of use by cattle or wildlife were observed at this location or anywhere along the canyon bottom. This spring site is the only one investigated that is in the John Henry member of the Straight Cliffs Formation.

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The Tibbett Canyon Seep is an area of diffuse dampness about 30 feet above the canyon floor along Warm Creek. Water periodically drips from the bottom of the Tibbett Canyon sandstone over a broad area of the canyon wall. The seepage evaporates or infiltrates into the alluvium at the base of the outcrop. This seep has been regularly monitored since 1989.

Flow from the Tibbett Canyon Member has also been found at what Andalex has named 14 North and 14 South Springs (Tibbett Bench 7 1/2 minute topographic map). The two seeps emanate from Tibbett Canyon Member exposed in the bottom of Tibbett Canyon. The seep in the main drainage is called 14 North Spring and the seep in the side canyon is called 14 South Spring. Observed flow was estimated at less than 1 gpm for each spring. A heavy efflorescence is present around the seeps and downstream for about 1,000 feet. There is evidence of use by cattle and wildlife.

Drip Tank Spring is located in Drip Tank Canyon, a tributary of Last Chance Creek. Water issues from bedding plane cracks in an overhanging ledge of Drip Tank member sandstone and a pool has formed directly beneath the ledge. Flow in October 1988 was estimated to be about 3-5 gpm. Cattle were seen using the site in February 1992, when flow was estimated to be about 2 gpm. Cottonwood trees grow along the side of the drainage.

Seep S-1 was initially observed in September 1990. There was no visible water, but Tamarisk were present and vegetation was anomalously healthy considering the drought conditions at the time. On subsequent visits the soil was damp but water was not found. No signs of wildlife usage have been seen. The seep area is located in the bottom of two converging drainages containing colluvial material. The seep appears to be at the base of paleochannel sandstones of the Drip Tank Member, but colluvium in the drainages may collect and store surface water and be the source of the seep. A hole was dug in the colluvium during the summer of 1992, and in March 1993, after an unusually wet winter, there was a trickle of about 1/8 gallon per minute from the excavation. The water flowed about 30 feet before seeping back into the colluvium. A water sample was taken. By June 1993 the area was dry.

Seep S-2 is located at the base of a massive paleochannel in the Drip Tank Member. Drips from the channel form a small pool 2 inches deep beneath the sandstone ledge, but no water has been seen flowing from the pool. Reeds and bull thistle grow around the ledge. The pool is accessible to small animals only.

The location designated Seep S-3 was noted because of the surface coatings on the sandstone. No standing or flowing water has been observed. The area is within the Drip Tank Member and is near the base of a thick paleochannel sandstone. Neither animal tracks or trails nor anomalous vegetation have been seen. This seep

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has not been included in Andalex' monitoring program because it does not appear to be a water resource.

Seep S-4 consists of wet sandstone with a few small periodic drips. It is located at the base of a thick paleochannel sandstone in the upper portion of the Drip Tank Member. Small vegetation grows around the seep but no signs of wildlife use have been seen.

An area of wet sandstone with a very few, minor drips was named seep S-5 during the 1990 survey. It was at the base of a massive sequence of paleochannel sandstones of the Drip Tank Member. Underlying finer grained material was acting as an aquitard. Carbonate and sulfate coatings were prevalent. Only a slight increase in vegetation was observed and no wildlife usage was noted. This site did not appear to be a source of water and has not been included in Andalex' monitoring program.

Seep S-6 is a moss-covered seepage area at the base of a cliff in the Drip Tank Member. Seepage feeds a pool totalling a few square feet in extent. Plants noted include serviceberry, Baltic Rush and dandelions. Small rodent tracks were noted.

Seepage at the base of the Drip Tank Member comprises seep S-7. The ground was damp below the drips but there was no standing water. No signs of wildlife were observed.

Seep S-8 is located at the base of a sandstone ledge in the Drip Tank Member. This site had been developed by ranchers in the past but subsequent floods have destroyed the improvements. No livestock usage was observed. A pool of water three feet by four feet by one foot deep was observed but no flow from the pool was evident.

Wesses Spring issues from the Drip Tank Member. It has been monitored since 1993. Flow up to 60 l/minute (16 gpm) has been measured.

Approximately one mile upstream of Wesses Spring a seep was found in 1994 near the base of a sandstone ledge in the lower Wahweap Formation. This seep has been designated Upper Wesses Seep. The seepage feeds a pool covering approximately 100 square feet and 2-3 feet deep. In March 1995, discharge from this pool measured 1,650 ml/minute (0.4 gpm). No livestock trails were noted, but some coyote tracks were found. The seep appeared to have minimal usage by wildlife and cattle.

Needle Eye Water has a catchment pond, filled with grasses and cattails, built around the source, but no water was visible during visits in October 1988 and February 1992. Pipes appear to carry water from the fenced pond to a watering basin

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below. Water issues from the Drip Tank member on the side of the canyon. Several tamarisk bushes grow in the area but vegetation was generally sparse.

John Henry Spring appears as seepage from the Drip Tank member along the bottom of the wash. A flow of approximately 4 gpm was observed during visits in October 1988 and February 1992. Cottonwood trees grow along the sides of the wash where the seepage discharges. Efflorescence is present along the wash below the spring. Evidence of use by cattle was seen.

Clints Spring issues from the Drip Tank member over a distance of about 50 feet along the bottom of the drainage. This spring had an estimated flow of 3-5 gpm in both October 1988 and February 1992. The flow from the spring continued down the channel for 200-300 feet before disappearing. There was evidence of use by cattle at both visits.

Tibbett Spring has been developed as a filling point for portable water tanks and piping, culverts, valves, and portable tanks were present during visits in 1988 and 1992. The main catchment pond was fenced to prevent entry by cattle. Flow was from near the base of the Drip Tank Member but it was not measurable. There was a trickle of water down the drainage below the pond. The trickle disappeared a short distance down the wash and the wash was dry beyond that point. There was a small grove of cottonwood trees at the pond and cattails were growing in the pond.

Brett Spring is near Tibbett spring. Water was not flowing in 1988 but roughly 1 gpm was discharging in 1992. Flow from the Drip Tank Member appeared over a 20' interval at the bottom of the drainage, and efflorescence was present along the drainage. There was evidence of use by cattle. Cottonwood trees were growing in the area of the seepage.

### *Aquifer Characteristics*

Ground water occurs in perched, locally saturated zones in the Straight Cliffs Formation. These zones are composed chiefly of fine- to medium-grained sandstone of low permeability (Table 1). The sandstone is typically a stream channel deposit and is enclosed by impermeable strata, so recharge is restricted. These perched zones are not capable of sustained withdrawal because of their limited areal extent, low hydraulic conductivity, and limited recharge.

There is presently no evidence of a regional aquifer within the potentially impacted strata above or below the coal seams. A slug test of MW-1 determined the hydraulic conductivity of the Tibbett Canyon Member to be 0.03 ft/day. The Calico Sandstone at the base of the John Henry Member is continuous over a large area, but permeabilities are similar to those of other sandstones of the Straight Cliffs Formation



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and generally one to two orders of magnitude lower than those of the Navajo Sandstone (Table I).

Springs 14 North and 14 South discharge from the Tibbett Canyon Member outcrop in the bottom of Wesses Canyon. This is in the trough of the Warm Creek syncline and is the lowest elevation at which the Tibbett Canyon Member crops out in the vicinity of the Smoky Hollow permit area. With the underlying Tropic Shale impeding downward flow, these two springs are at the spill point of the Tibbett Canyon Member. The insignificant discharge from these springs indicates that the Tibbett Canyon Member is not receiving recharge and transporting ground water on a regional scale.

Recharge at the Tibbett Canyon Member outcrops is insignificant due to the cliff-forming nature of this unit. Ground water conditions are such that recharge is probably proximal to the discharge at Tibbett Canyon Seep and to MW-1. Fine grained strata of the Straight Cliffs Formation generally inhibit downward movement of recharge, but in areas around Tibbett Canyon Seep there is only a thin veneer of overlying interbedded clays, so recharge of the Tibbett Canyon may occur from infiltration of local precipitation. It is uncertain to what degree fractures contribute to hydraulic conductivity; however, it would be reasonable to assume that fractures may enhance local recharge where overlying clay rich strata are thin or absent.

The coal bearing strata are separated from underlying sandstones by six hundred to seven hundred feet of low permeability Tropic Shale. The Navajo Sandstone aquifer has the greatest potential for ground water development. It lies more than 1,000 feet beneath the lowest coal-bearing beds that would be mined. The Navajo aquifer is recharged from the Boulder Mountains to the north, the Kaibab Upwarp to the west, and the Paria Plateau to the southwest. Recharge is estimated to be 8,300 to 16,900 acre-feet per year (Blanchard, 1986).

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**TABLE 1**  
Hydraulic Conductivity of Sandstones

Sandstone	Hydraulic Conductivity (K) in feet/day	
	Horizontal	Vertical
Tibbett Canyon Member (Andalex, 1994)		
outcrop-stratified	0.028	0.0054
outcrop-massive	0.055	0.069
Navajo Sandstone (Blanchard, 1969)		
	0.64	0.41
	0.38	0.22
	--	1.36
	--	4.66
	2.12	2.10
	9.57	8.86
Straight Cliffs Formation (Plantz, 1985)		
H	--	0.89
	0.0036	0.0021
	1.26	0.88
	1.06	0.91
	0.018	0.009
I	0.37	0.2
	<0.00037	<0.00037
	0.00063	0.00034
J	0.085	0.027
	0.0039	0.0039

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Before Lake Powell inundated Glen Canyon, the ground water gradient in the Navajo aquifer was towards the canyon. When Lake Powell was first filled, this gradient was reversed locally. When bank storage and water in the lake reached equilibrium, the gradient was again toward the canyon, although somewhat flatter. In the Kaiparowits Plateau area, 76 springs that discharged from the Glen Canyon Group (including the Navajo Sandstone) were identified in 1965. Discharge was estimated to be 924 gallons per minute, which would be 1490 acre-feet per year if a constant rate of discharge were assumed. Lake Powell inundated 40 of these springs, which accounted for 74% of the estimated discharge (Blanchard, 1986).

Aquifers in the Navajo Sandstone have been tapped by several wells in areas near the CIA, supplying water for domestic use and for a fish hatchery. One well in Wahweap Creek near Big Water reportedly can yield more than 1,000 gpm, the hydraulic conductivity of the aquifer apparently being enhanced by fractures and joints. Total withdrawal from these wells was approximately 500 acre-feet per year in 1976 (BLM), most of it for the fish hatchery.

### Water Use

A listing of water rights for the area shows that the BLM and the State of Utah Division of Lands own perfected rights to numerous small flows at springs and streams for stockwatering. Individuals hold unapproved rights for stockwatering at a few springs and streams and for water wells in T. 40 S., R. 3 E. and T. 41 S., R. 3 E. AMCA Coal Leasing, Inc., a subsidiary of Andalex, has filed for rights to a large volume of ground water at depths of up to 4,000 feet for use at the Smoky Hollow Mine, but wells have not been drilled. Water rights on several million acre-feet of ground water and Colorado River water were filed as part of the defunct Kaiparowits power project but never were developed. No producing water wells exist in the CIA. The nearest municipal water well is located near Big Water, Utah and produces out of the Navajo sandstone.

### III. BASELINE CONDITIONS OF SURFACE AND GROUND WATER QUALITY AND QUANTITY.

#### Surface Water

##### *Surface Water Quantity*

Wahweap, Warm, and Last Chance Creeks together drain approximately 85% of the Kaiparowits Plateau. Wahweap Creek is outside the CIA, but canyons of the Warm Creek drainage form the west boundary of the CIA and Last Chance Creek flows through the middle. The Croton Canyon drainage, which was tributary to Last Chance Creek before Lake Powell was filled, is the east boundary. All these

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drainages discharge into Lake Powell. Streams draining the Kaiparowits Plateau generally discharge only in direct response to rainfall or snowmelt. Stretches of some stream beds carry intermittent flow that originates from seeps and springs, but the flow disappears after short distances due to evapotranspiration and seepage into the alluvium. Small headwater drainages are ephemeral. The canyons into which these feed are often classified as intermittent simply because they drain an area of at least one square mile, but most receive no ground water baseflow and from a functional viewpoint they are ephemeral. The lower reaches of major drainages are possibly perennial during most years (BLM, 1976).

There is a large seasonal variation of stream flow. Most runoff from higher elevations occurs in late-spring and early-summer when streams are fed by melting snowpack and seasonal rains. Most peak flow runoff at lower elevations is from late-summer cloudbursts. Cloudbursts generally cover a limited area, but because of high precipitation rates an area of only a few square miles they may produce discharges of several hundred to several thousand cubic feet per second. Estimated total annual mean runoff for all streams of the Kaiparowits Plateau is 6,000 acre-feet. Streams are of little value as water supplies because they are dry much of the year.

Streams have been monitored by Andalex at four locations in the Smoky Hollow area with single stage samplers and crest stage gages since 1989, and single stage samplers were placed in February 1992 at five additional locations. As of 1995 there were fourteen stream monitoring stations (Figure 2). Discharges of different streams from a single storm are not necessarily in direct proportion to the size of the respective areas drained by the streams, and some stations may show no flow while flow is indicated in adjacent channels. High water marks from flow events and channel cross sections were used to calculate maximum discharge rates using the Manning equation. The largest flow determined so far is 430 cfs at Station SS-2. The calculated 100 year-6 hour discharge for Smoky Hollow is 770 cfs.

### *Surface Water Quality*

Lake Powell water is classified by the Utah Division of Health as:

- 1C - protected for domestic use with prior treatment,
- 2A - protected for recreational bathing (swimming),
- 2B - protected for recreational uses except swimming,
- 3B - protected for warm water aquatic life, and
- 4 - protected for agricultural uses.

The streams flowing into Lake Powell from the CIA are classified as:

- 2B - protected for recreational uses except swimming,
- 3B - protected for warm water aquatic life, and
- 4 - protected for agricultural uses.

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Applicable limits for TDS, total iron, total manganese, and pH are given in Table 2.

Regional studies by the USGS and others indicate that, for the Kaiparowits Plateau general, the chemical quality of surface water is relatively good in headwater areas but deteriorates downstream. TDS in surface water ranges from 100 to 500 mg/l in headwater areas, 500 to 5,000 mg/l in the lower reaches of most streams, and 3,000 to 10,000 mg/l in the lower reaches of the three principal drainages, Wahweap, Warm, and Last Chance Creeks (Price, 1977). The dominant ions in the headwaters are calcium and bicarbonate; in the middle reaches calcium, magnesium, sodium, and bicarbonate; and in the lower reaches sodium, calcium, and sulfate. In the lower reaches of Last Chance and Wahweap Creeks, concentrations of arsenic, cadmium, lead, manganese, and selenium frequently exceed EPA primary drinking water standards (USGS, 1979). Similar water quality is assumed for Warm Creek, which lies between them. Water in Lake Powell contains 550 to 815 mg/l dissolved solids.

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**TABLE 2 (TABLE VII-12 of Andalex)  
SURFACE WATER QUALITY  
DATA SUMMARY: 1989 - 1993**

Sampler	Period Sampled	TSS (mg/l)		TDS (mg/l)		pH	
		Range	Avg.	Range	Avg.	Range	Avg.
SS-1	7/27/90 - 9/21/94	294 - 51,700	29,951	282 - 2,849 <sup>2</sup>	829 <sup>2</sup>	7.2 - 7.6	7.4
SS-2	8/15/92 - 11/1/92	8,760 - 148,000	65,665	286 - 1,420 <sup>2</sup>	693 <sup>2</sup>	7.5 - 7.8	7.65
SS-3	8/16/89 & 9/7/92	3,970 - >90,000	46,985	332 - 594 <sup>2</sup>	463	7.3 - 7.5	7.4
SS-4	7/27/90 - 9/1/93	80,100 - 180,000	130,050	640 <sup>2</sup> - 2,313 <sup>2</sup>	1,204 <sup>2</sup>	7.1 - 7.6	7.2
SS-5	5/30/92 - 9/20/92	11,500 - 65,000	31,433	290 - 808 <sup>2</sup>	465	7.1 - 7.6	7.4
SS-6	8/15/92	9,750		1,240 <sup>2</sup>		7.7	
SS-7	No Samples	Installed March 1992, destroyed August 1992, no samples collected					
SS-8	7/11/92 - 3/7/95	10 - 206,000	31,385	326 - 6,840 <sup>2</sup>	1,678 <sup>2</sup>	7.4 - 8.3	7.9
SS-9	7/11/92 - 3/7/95	33 - 56,100	24,925	410 - 8,680 <sup>2</sup>	1,852 <sup>2</sup>	7.5 - 8.5	7.9
SS-10	3/6/93 - 3/7/95	6 - 283,000	30,738	516 <sup>2</sup> - 2,760 <sup>2</sup>	1,317 <sup>2</sup>	6.9 - 8.3	7.8
SS-11	4/94 - 3/95	No Samples Collected					
SS-12	4/94 - 3/95	No Samples Collected					
SS-13	10/15/94	125		2,300 <sup>2</sup>		7.9	
SS-14	3/7/95	Not Sampled		1,260 <sup>2</sup>		8.1	
101	7/11/92	49,200		826 <sup>2</sup>		7.1	
102	7/11/92	252		426		6.6	
103	7/11/92	41,700		490		7.4	
104	8/15/92	22,800		976 <sup>2</sup>		7.5	
105	8/15/92	24		1,560 <sup>2</sup>		7.3	
106	8/29/92	6		1,320 <sup>2</sup>		8.1	
107	8/29/92	20		1,260 <sup>2</sup>		7.6	

**Comments**

- (1) Average calculated using "(detection limit)\*0.5" if amount present as "< detection limit".
- (2) Exceeds SDW standard of 500 mg/l for TDS.
- (3) Exceeds SDW standard of 0.3 mg/l for Iron.
- (4) Exceeds SDW standard of 0.05 mg/l for Manganese

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TABLE 2 (Continued)  
SURFACE WATER QUALITY  
DATA SUMMARY: 1989 - 1993

Sampler	Period Sampled	TSS (mg/l)	TDS (mg/l)	pH
108	9/7/92	528	2,900 <sup>2</sup>	7.8
109	9/18/92	8	928 <sup>2</sup>	7.9
110	9/18/92	67	1,130 <sup>2</sup>	7.7
111	9/20/92	10	2,140 <sup>2</sup>	8.1
112	11/1/92	8	1,850 <sup>2</sup>	8.3
Primary Drinking Water (PDW) Standard		(no PDW standard)	2,000	(no PDW standard)
Secondary Drinking Water (SDW) Standard		(no SDW standard)	500	6.5 - 8.5
Utah Division of Water Quality		(no WQ standard)	1,200 Class 4	6.5 - 9.0 Classes 1C, 2A, 2B, 3B, and 4

Comments

- (1) Average calculated using "(detection limit)\*0.5" if amount present as "< detection limit".
- (2) Exceeds SDW standard of 500 mg/l for TDS.
- (3) Exceeds SDW standard of 0.3 mg/l for Iron.
- (4) Exceeds SDW standard of 0.05 mg/l for Manganese

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TABLE 2 (Continued)  
SURFACE WATER QUALITY  
DATA SUMMARY: 1989 - 1993

Sampler	Period Sampled	Iron (Total - mg/l)		Iron (Dissolved - mg/l)		Manganese (Total mg/l)		Manganese (Diss. mg/l)	
		Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
SS-1	7/27/90 - 9/21/94	<0.05 - 220 <sup>3</sup>	33.4 <sup>1,3</sup>	<0.05	<0.05 <sup>1</sup>	<0.01 - 5.3 <sup>4</sup>	1.57 <sup>1,4</sup>	0.84	0.84
SS-2	8/15/92 - 11/1/92	5.36 <sup>2</sup>		<0.05 - 0.06	<0.05 <sup>1</sup>	0.14 <sup>4</sup>		<0.02 - 0.03	0.02 <sup>1</sup>
SS-3	8/16/89 & 9/7/92	0.58 <sup>2</sup>		<0.05		2.9 <sup>4</sup>		<0.02	
SS-4	7/27/90 - 9/1/93	8.06 <sup>2</sup>		<0.05 - 0.41	0.22 <sup>1</sup>	<0.02 - 0.52 <sup>4</sup>	0.4 <sup>1,4</sup>	<0.02 - 0.22	0.11 <sup>1</sup>
SS-5	5/30/92 - 9/20/92	No Samples		<0.05 - 0.13	0.06 <sup>1</sup>	No Samples		<0.02 - 0.86	0.2 <sup>1,4</sup>
SS-6	8/15/92	0.88 <sup>2</sup>		No Samples		0.02		No Samples	
SS-7		No Samples							
SS-8	7/11/92 - 3/7/95	3.94 <sup>2</sup> - 9.4 <sup>3</sup>	6.7 <sup>2</sup>	<0.05 - <0.05	<0.05 <sup>1</sup>	0.05 - 1.1 <sup>4</sup>	0.52 <sup>4</sup>	<0.02 - 0.05	<0.02 <sup>1</sup>
SS-9	7/11/92 - 3/7/95	3.56 <sup>2</sup> - 533 <sup>3</sup>	147 <sup>2</sup>	<0.05 - 20.2	3.21 <sup>1</sup>	0.28 <sup>4</sup> - 5.04 <sup>4</sup>	1.94 <sup>4</sup>	<0.02 - 3.93	0.66 <sup>2</sup>
SS-10	3/6/93 - 9/1/93	0.55 <sup>2</sup> - 253 <sup>3</sup>	99 <sup>2</sup>	<0.05 - 2.24	0.67 <sup>1</sup>	<0.02 - 4.10 <sup>4</sup>	1.51 <sup>1,4</sup>	<0.02 - 1.66	0.30 <sup>2</sup>
SS-11	4/94 - 3/95	No samples collected							
SS-12		No samples collected							
SS-13	10/15/94	83.4 <sup>3</sup>		<0.05		11 <sup>4</sup>		0.35	
SS-14	3/7/95	340 <sup>2</sup>		<0.05		2.11 <sup>4</sup>		<0.02	
101	7/11/92	19.2 <sup>3</sup>		No Samples		3.58 <sup>4</sup>		No Samples	
102	7/11/92	14.3 <sup>3</sup>		No Samples		0.34 <sup>4</sup>		No Samples	
103	7/11/92	38.5 <sup>3</sup>		No Samples		4.55 <sup>4</sup>		No Samples	
104	8/15/92	3.88 <sup>2</sup>		No Samples		0.40 <sup>4</sup>		No Samples	
105	8/15/92	0.11		No Samples		<0.02		No Samples	
106	8/29/92	No Samples		<0.05		No Samples		<0.02	
107	8/29/92	No Samples		<0.05		No Samples		<0.02	
PDW std.		(no PDW standard)		(no PDW standard)		(no PDW standard)		(no PDW standard)	
SDW std.		0.3		(no SDW standard)		0.05		(no SDW standard)	
Water Q'ty std.		(no WQ standard)		1.000 Class 3B		(no WQ standard)		(no WQ standard)	

## Comments

- (1) Average calculated using "(detection limit)\*0.5" if amount present as "< detection limit".
- (2) Exceeds SDW standard of 500 mg/l for TDS.
- (3) Exceeds SDW standard of 0.3 mg/l for Iron.
- (4) Exceeds SDW standard of 0.05 mg/l for Manganese



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TABLE 2 (Continued)  
SURFACE WATER QUALITY  
DATA SUMMARY: 1989 - 1992

Sampler	Period Sampled	Iron (Dissolved) (mg/l)	Manganese (Dissolved) (mg/l)
108 <sup>s</sup>	9/7/92	<0.05	<0.02
109 <sup>s</sup>	9/18/92	<0.05	<0.02
110 <sup>s</sup>	9/18/92	<0.05	<0.02
111 <sup>s</sup>	9/20/92	<0.05	<0.02
112 <sup>s</sup>	11/1/92	<0.05	0.02

Comments

- (1) Average calculated using "(detection limit)\*0.5" if amount present as "<detection limit".
- (2) Exceeds SDW standard of 500 mg/l for TDS.
- (3) Exceeds SDW standard of 0.3 mg/l for Iron.
- (4) Exceeds SDW standard of 0.05 mg/l for Manganese
- (5) Samples not analyzed for Total Iron or Total Manganese

Runoff in the region has a high suspended and dissolved solids content. Principal factors contributing to the salinity of runoff in the Kaiparowits is evapotranspiration and seepage of saline ground water. This is especially true for flow on or downstream of the Tropic Shale, which has a high soluble minerals content and is easily eroded by rapid runoff. Concentrations of suspended solids in streams are directly proportional to flow, but for dissolved solids they are usually inversely proportional. As a result, the chemical quality of water is usually best during high flow and worst during low flow. Streams are usually saturated with respect to suspended sediment during snowmelt and storm runoff. During periods of very low runoff in the region, salts precipitate on the beds and banks of streams. These salts are readily dissolved in the initial periods of subsequent runoff events, thus causing initially high concentrations of dissolved solids. As runoff continues, fewer of these salts are available for solution, resulting in lower concentrations of dissolved solids in the surface runoff.

Water quality data collected to date from the permit and adjacent areas indicate a high degree of both spatial and temporal variability. From August 1989 to March 1995 Andalex collected water samples from single stage samplers installed in the vicinity of the proposed Smoky Hollow Mine. Results for totals suspended solids (TSS), total dissolved solids (TDS), total iron, total manganese, and pH are summarized in Table 2. Total suspended solids (TSS), concentrations of major and trace elements, and other parameters are reported by Andalex in the Smoky Hollow and LMPA PAP's. Measurements of TSS, pH and specific conductance are subject to possible error due to the lag time between storm events and sample collection,

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which is caused by the poor accessibility of the sampling sites. TSS values in the Smoky Hollow area ranged from 6 to around 280,000 mg/l.

Andalex has used Primary Drinking Water (PDW) and Secondary Drinking Water (SDW) standards established by the State of Utah Division of Drinking Water as the standard for quality comparison. These drinking water standards are generally more stringent than water quality standards set by the Utah Division of Water Quality for natural waters.

SS-1, located in Smoky Hollow above the proposed disturbed area, was sampled six times between August 16, 1989 and November 1, 1992. There is no correlation between elevated TSS and TDS values and flow depth measurements. In three of seven analyses, TDS exceeds the SDW standard of 500 mg/l. Average TDS level over this period is 446 mg/l, but for the period from July 1990 to September 1994 it is 829 mg/l (Table 2). Total iron exceeds the SDW standard in two samples. High iron concentrations show a strong correlation with elevated TDS values. There appears to be a decrease in iron concentration with each subsequent sampling event. Manganese is in excess of the SDW standard of 0.05 mg/l in three samples.

At SS-2, four samples were collected between August 15, 1992 and November 1, 1992. The August 15 sample has a TDS concentration of 1,420 mg/l, a total iron concentration of 5.36 mg/l and total manganese of 0.14 mg/l. All three are in excess of the respective SDW standard. Iron and manganese concentrations show a decrease with time. The August 29 sample had a nitrate concentration of 13.55 mg/l. The PDW standard for nitrate is 10 mg/l. As with SS-1, there is no correlation between increased water depth and elevated concentrations of stream constituents.

Samples were collected at SS-3 below the proposed mine site on August 16, 1989 and September 7, 1992. On August 16 the crest gage measured a storm flow of 9 cfs, and the water sample had 594 mg/l (calculated) TDS, 0.58 mg/l total iron, and 2.9 mg/l total manganese, each exceeding SDW standards. All other analyses were within PDW and SDW standards.

SS-4, located in Smoky Hollow approximately a mile and a quarter below the proposed mine site, was sampled July 27, 1990, August 29, 1992, and September 1, 1993 but only manganese was analyzed in the first sample. Total manganese in that sample was 0.52 mg/l, which exceeds the SDW standard. The sample collected in August 1992, after a flow event of 124.6 cfs, had a TSS level of 180,000 mg/l, and a TDS level of 640 mg/l. Selenium and sulfate were also in excess of recommended drinking water standards.

At SS-5, the lower of two stations above the proposed Smoky Hollow Mine, four samples were collected following precipitation events during the spring and fall of 1992. Total suspended solids were moderately high, averaging 31,433 mg/l.

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TDS, sulfate, and manganese each exceeded the SDW standard once, in different samples.

A single sample from SS-6, located in a minor drainage at the proposed mine site, was collected on August 15, 1992. Sulfate concentration (722 mg/l) exceeded the PDW standard of 250 mg/l, and 1,240 mg/l TDS and 0.88 mg/l iron exceeded SDW standards.

Samples collected from sampler SS-8, located at the mouth of Wesses Canyon, showed a wide range in TSS levels, from 10 mg/l to 206,000 mg/l. TDS concentrations fluctuated randomly, and were in excess of the recommended regulatory level of 500 mg/l on most occasions. Average total iron and total manganese levels exceed SDW standards. Missing depth data make it difficult to correlate between flow rate and TSS, TDS, or the concentration of other chemical parameters.

SS-9, situated at the lower end of John Henry Canyon, was sampled between July 1992 and March 1995. TSS ranged from 33 mg/l to 56,100 mg/l. TDS concentrations averaged 1,852 mg/l. Average total iron and total manganese are above the SDW standard.

The pH at SS-10 exhibited the broadest range, 6.9 to 8.3, of any site sampled during the monitoring period. TSS ranged from 6 to 283,000 mg/l, also the broadest range measured. Total iron and total manganese averaged above SDW standards.

SS-11 is a flow gauge that was installed in the spring of 1994 for observation purposes. It is located on the southern limit of the permit area and about 1,200 feet below the canyon where MW-1 is located. This station was destroyed by the 9/20/94 event and was later replaced.

Another flow gauge, SS-12, was installed to measure flow height in the Warm Creek channel just upstream of the proposed Smoky Hollow Mine yard. Flow height of 3.0 feet was measured following the 9/20/94 event.

Flow gauge SS-13 was installed below the junction of Tibbet Canyon and the Warm Creek drainage. A flood height of 3.0 feet was recorded after the 9/20/94 event. One water sample has been collected, on October 15, 1994.

SS-14 was installed in December 1994. It is located in Warm Creek about 1 1/2 miles below SS-13. This location will be used to collect grab samples as well as flow height and velocity measurements. One sample has been collected, on March 7, 1995.

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Grab samples 101, 102, 104-109, 111-113, and 116 were collected from pooled water at five different sites in and around the permit area during the fall of 1992. Samples were collected from flood pools following individual precipitation events, and TSS, TDS, pH, total iron, and total manganese are reported along with other parameters in the Smoky Hollow PAP.

Andalex' evaluation of their own data does not fully support two observations made in the regional studies discussed earlier: 1) that TDS increases downstream, and 2) that high flow conditions cause a decrease in TDS while low flow results in elevated TDS. According to the Andalex data, there is no downstream increase in TDS within the permit area. The increased TDS found in the regional studies is probably caused by Tropic Shale outcrops downstream of the Smoky Hollow permit area. Also, the data collected by Andalex indicate that increased discharge results in increased levels of ionic constituents in stream waters, and variations in water chemistry correlate well with variations in precipitation. The Andalex data do, however, generally support the finding that after prolonged dry spells the TDS is elevated in the initial sampling of ensuing runoff events and shows a systematic decrease with each subsequent event.

Temporal and spatial variations in surface water chemistry can be ascribed to a number of factors. The steep topography and easily erodible formations in the southern Kaiparowits Plateau cause runoff to be swift and sediment laden. Summer precipitation events vary in intensity and usually are concentrated into a relatively small area. The Straight Cliffs Formation consists of interbedded sandstones and mudstones of variable thicknesses and mineral affinities. The sandstones are well indurated and consequently not susceptible to erosion. However, the heterogeneous mudstone intervals are readily eroded, providing the surface waters with an available source of both suspended and dissolved constituents. X-ray diffraction analyses of the mudstone overburden lists silica, potassium-feldspar, gypsum, kaolinite, and illite/smectite. Channel transmission losses result in variations in surface water quantity, while evapotranspiration causes salts to build in stream sediments. These factors, acting in concert, cause the wide range of concentrations observed and also elevate certain constituents above the recommended primary and secondary drinking water standards.

### Ground Water

#### *Ground Water Quality*

Little or no ground water quality information is available for large areas in the Kaiparowits coal basin. Dissolved solids concentrations in ground water in the vicinity of the proposed Smoky Hollow Mine are estimated to range from 500 to 3,000 mg/l, and south of the proposed mine to range from 1,000 to 10,000 mg/l.

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To more accurately determine baseline ground water quality, Andalex initiated a sampling program in December 1989 and has periodically sampled and analyzed ground water from monitoring well MW-1, Tibbett Canyon Seep, seep S-2, and seep S-4. No measurable flow has occurred at seeps S-3 and S-5 since monitoring began.

Andalex has based its evaluation of the ground water quality on primary (PDW) and secondary (SDW) drinking water standards established by the State of Utah Division of Drinking Water. In this CHIA reference is also made to the standards set by the Utah Division of Water Quality in R317, Utah Administrative Code, Standards of Quality for Waters of the State. The Drinking Water Standards are generally more stringent than the Water Quality Standards when a parameter is listed in both, but many parameters are unique to one set of standards or the other.

Ground water quality data collected up through April 1995 are presented in Appendix VII-2 and Tables VII-3, VII-6, and VII-7 in the Smoky Hollow PAP and Appendix (LMPA) VII-3 of the LMPA PAP. Data on TDS, total iron, total manganese, and pH are summarized in Table 3 below. Table 3 also includes USGS data from May 1974 (BLM, 1976) for three of the springs. Andalex' analyses for total iron and total manganese were inconsistent from 1989 to 1992, with many analyses done for dissolved rather than total metals. Minimum detection limits have varied due to utilization of several laboratories. There is also uncertainty as to whether or not consistent field methods have been used in collecting and preserving samples. Water quality data from the USGS are referred to in the PAP but field and analytical procedures are not always known, and compatibility of the Andalex data with data from other sources cannot be confirmed.

### *Wahweap Formation*

The Wahweap Formation overlies the Straight Cliffs Formation conformably and is an interbedded sandstone-mudstone unit (Doelling and Davis, 1989). The Wahweap Formation crops out near the northwest corner of the LMPA. Plantz (1985) indicates that the Wahweap generally yields water slowly to springs, generally less than 5 gpm. Estimated flow of Upper Wesses Seep, the only seep in the Smoky Hollow area that issues from the Wahweap Formation, was less than 0.5 gpm in October 1994. This seep issues from the base of a sandstone channel underlain by fine-grained sediments. Water sampled in 1994 had a very high field reading for conductivity with a field pH of 6.9. Laboratory TDS was 664 mg/l. Dissolved iron and manganese were .1 and .28 mg/l respectively, while total iron and manganese had readings of .34 and .32 respectively. Sulfate concentration was analyzed at 233 mg/l and no zinc was detected. Measured flow in March 1995 was 1,650 ml/minute (0.4 gpm). Laboratory conductivity was 10,000 umhos/cm and TDS was 9,170 mg/l. Sulfate concentration was 5,800 mg/l and sodium was 2,060 mg/l. Total iron and manganese were below detection limits (Table 3).

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There are no known wells in the Wahweap Formation in the permit or adjacent areas. A review of drilling logs indicate that none of the exploratory drill holes encountered groundwater in the Wahweap Formation. Due to the absence of the formation over much of the permit area and the lack of water resource development of the formation, the Wahweap is not considered an aquifer in the permit and adjacent areas.

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TABLE 3

Sample Location (Dates of Monitoring by Andalex)	TDS (mg/l))		Total Iron (mg/l)		Total Manganese (mg/l)		pH	
	Range	Avg	Range	Avg	Range	Avg	Range	Avg
Drip Tank Member								
S-1 (9/90 - 6/12/93)	(one sample - no analysis in PAP)							
S-2 (9/30/90 - 9/17/93)	911 - 3,800	1,560	<0.02 - 0.34	0.12	<0.01 - 0.02	<0.02	6.4 - 8.7	7.4
S-3 (9/90 - ?)	(no water)							
S-4 (2/9/91 - 9/17/93)	158 - 208	184	0.03 - 0.20	0.08	<0.01 - 0.02	<0.02	6.8 - 8.8	8.0
S-5 (9/90 - ?)	(no water)							
S-6 (4/18/95)	390 (one sample)		4.66 (one sample)		0.34 (one sample)		7.6 (L - one sample)	
S-7 (4/18/95)	264 (one sample)		<0.05 (one sample)		<0.02 (one sample)		8.0 (L - one sample)	
S-8 (4/18/95)	556 (one sample)		0.15 (one sample)		<0.02 (one sample)		7.5 (L - one sample)	
(F) Field pH (L) Lab pH								

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TABLE 3 (continued)

Sample Location (Dates of Monitoring by Andalex)	TDS (mg/l))		Total Iron (mg/l)		Total Manganese (mg/l)		pH	
	Range	Avg	Range	Avg	Range	Avg	Range	Avg
Drip Tank Member								
Drip Tank Spring (10/17/88 - 10/21/94)	805 - 1,160 531 (USGS)	1,020	0.09 - 1.88 0.030 (diss. - USGS)	0.73	0.02 - 0.13 0.080 (diss. - USGS)	0.07	7.1 - 7.7 8.0 (USGS)	7.4
Tibbett Spring (2/5/92 - 9/25/93)	743 - 2,670 1,140 (USGS)	1,708	0.11 - 0.91 (two samples) 0.010 (diss. - USGS)	0.56	<0.01 - 0.03 (two samples) 0.010 (diss. - USGS)	0.02	7.3 - 7.5 7.7 (USGS)	7.4
Needle Eye Water (10/15/93 - 10/19/94)	516 - 556	533	0.19 - 0.95	0.65	<0.02	<0.02	7.1 - 7.5	7.3
Wesses Spring (5/29/93 - 3/28/95)	714 - 1,080 1,230 (USGS)	884	0.08 - 0.45 ---- (USGS - no analysis)	0.27	<0.02 - 0.19 ---- (USGS - no analysis)	0.10	7.5 - 8.8 7.5 (USGS)	7.9
John Henry Spring (2/05/92 - 10/19/94)	662 - 2,660	1,350	0.19 - 1.68	0.67	0.56 - 0.85	0.58	7.7 - 8.0	7.9
Clints Spring (2 05/92 - 10/19/94)	514 - 906	650	0.15 - 1.72	0.75	<0.02 - 0.06	0.04	7.2 - 7.8	7.5
Brett Spring (10/17/88 - 9/25/93)	976 - 2,420	1,772	0.483 - 242(?) (two samples)	121.5(?)	0.865 - 5.17(?) (two samples)	3.45(?)	7.1 - 7.3(L) (two samples) 7.85(F)	7.2
(F) Field pH (L) Lab pH								



# CHIA - SMOKY HOLLOW

TABLE 3 (continued)

Sample Location (Dates of Monitoring by Andalex)	TDS (mg/l)		Total Iron (mg/l)		Total Manganese (mg/l)		pH	
	Range	Avg	Range	Avg	Range	Avg	Range	Avg
<b>John Henry Member</b>								
Section 10 Spring (10/88 - 10/25/93)	1,730 (one sample)		54 (one sample)		1.15 (one sample)		7.9 (one sample)	
<b>Tibbett Canyon Member</b>								
Tibbett Canyon Seep (12/27/89 - 9/17/93)	820 - 988	900	<0.02 - 0.67	0.21	<0.01 - 0.10	0.03	7.5 - 9.3	8.5
MW-1 (9/30/90 - 12/09/93)	707 - 1,350	1,019	<0.05 - 1.97	0.54	<0.01 - 0.12	0.03	7.5 - 11.5	9.4
14 North Spring (2/5/92)	1,179 (one sample)		0.273 (one sample)		<0.01 (one sample)		8.49 (one sample)	
14 South Spring (2/5/92 - 10/25/93)	1,260 - 2,668	1,889	0.125 - 3.09 (two samples only)	1.61	<0.01 - 0.07	0.03	7.5 - 7.8(L) 8.38(F)	7.6
<b>Wahweap Formation</b>								
Upper Wesses Seep 10/19/94 - 3/28/95)	664 - 9,170 (two samples only)		<0.05 - 0.34 (two samples only)		<0.02 - 0.32 (two samples only)		7.4 - 8.0 (two samples only)	
Primary Drinking Water (PDW) Standard	2,000		(no PDW standard)		(no PDW standard)		(no PDW standard)	
Secondary Drinking Water (SDW) Standard	500		0.3		0.05		6.5 - 8.5	
Utah Division of Water Quality - Most Stringent Applicable Standard	1,200 Class 4		1,000 (acid soluble) Class 3B		(no standard)		6.5 - 9.0 Classes 1C, 2A, 2B, 3B, and 4	

(F) Field pH (L) Lab pH

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### Drip Tank Member

Baseline quality of perched ground water in the Drip Tank Member is represented by S-2 and S-4 sample data. TDS and sulfate concentrations are significantly lower at S-4 (184 mg/l and 24.1 mg/l average, respectively) than at S-2 (1,560 mg/l and 787.5 mg/l average, respectively) or most other ground water source that have been sampled: S-6 and S-7 have comparably low sulfate levels. Total iron ranges from below detection to 0.34 mg/l at S-2 and from 0.03 mg/l to 0.20 mg/l at S-4. One sample from S-2 has 0.22 mg/l dissolved iron but no total iron analysis. Total manganese is at or below detection limit of 0.02 mg/l in all samples from S-2 and S-4. Field measurements of pH from S-2 and S-4 range from 6.4 to 8.8 and average 7.4 for S-2 and 8.0 for S-4. Zinc exceeds the SDW standard of 5.0 mg/l in one of twelve samples collected from S-2 (5.5 mg/l on 2/9/91). No significant seasonal variations or trends in ground water quality at seeps S-2 or S-4 are apparent.

Additional springs issuing from the Drip Tank Member were sampled as part of Andalex' February 1992 survey. Locations of these springs are indicated on Figure 3. TDS, total iron, total manganese, and pH values up through March 1995 are summarized in Table 3. Average TDS concentrations at these springs range from 533 to 1,772 mg/l, and all samples collected have exceeded the SDW standard for TDS. The SDW standard for sulfate is exceeded frequently in samples from John Henry, Brett, Clints, Tibbett, Wesses, and Drip Tank Springs. Total iron varies from 0.08 to 242 mg/l and total manganese from <0.01 to 5.17 mg/l. Both total iron and total manganese average concentrations exceed the SDW standards in the Drip Tank, Brett, and John Henry Springs samples, and at the four remaining springs the average for either total iron or total manganese exceeds the SDW standard.

During the November 1994 field investigation seeps S-6, S-7, and S-8 were found issuing from the lower portion of the Drip Tank Member in the LMPA. Insufficient water was available for sample collection in 1994 but samples were collected in April 1995 (Table 3). In these three seeps TDS and sulfate concentrations are at the lower end of values found in the Drip Tank Member, but S-6 indicates very high total iron and manganese. Additional survey work in April 1995 found no other seeps or springs in the area.

The February 5, 1992 sample from Clint Spring was the only sample from the Drip Tank Member to exceed the PDW standard of 0.002 mg/l for mercury. All other parameters are below limits of the SDW and PDW standards.

Ground water in the Kaiparowits Plateau region was sampled and analyzed by the U.S. Geological Survey in the spring of 1974. Sampling sites in the CIA, shown on Figure 3, included Drip Tank, Tibbett, and Wesses Springs. Data on TDS, dissolved iron, dissolved manganese, and pH for those three springs are included in

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Table 3. The data indicate an increase in TDS from 1974 to 1992 at Drip Tank Spring, but a decrease at Tibbett Spring. These inconsistencies may result from different methods of collection and analysis, but they may indicate a variable nature in the quality of the water that discharges from the Drip Tank Member.

### *John Henry Member*

The Tibbett Bench 7 1/2 minute topographic map shows a spring in Section 10 approximately 2 miles southwest of the proposed mine. This spring is apparently located in the John Henry Member. However, no evidence of a spring was found at this location during the February 1992 survey by Andalex, and no seeps or springs that were found during the September 1990 or February 1992 surveys issue from the John Henry Member. In October 1993 a pool of water was found at the Section 10 site and sampled. In that sample total iron and manganese are extremely high, 54 and 1.15 mg/l respectively, but TDS is only 1,730 mg/l. The Section 10 location will be rechecked by Andalex periodically during future field surveys.

### *Tibbett Canyon Member*

Baseline ground water quality of the Tibbett Canyon Member is represented by the Tibbett Canyon Seep and MW-1 sample data. Springs 14 North and 14 South also issue from the Tibbett Canyon Member.

TDS concentrations in samples from MW-1 and 14 South exceed the Utah Water Quality Standard, and one sample from 14 South also exceeds the PDW standard. TDS concentrations in ground water from MW-1 have a wider range than those from Tibbett Canyon Seep, and the average is higher. Total dissolved solids concentrations in samples from 14 North and 14 South Springs (1,179 and 1,889 mg/l, respectively) exceed the SDW standard and are higher than the average TDS concentration from both MW-1 and the Tibbett Canyon Seep, suggesting an increase in TDS concentration in the downgradient direction. Sulfate and TDS increased steadily from 1990 to 1993 in MW-1. High sulfate levels have also been found in Tibbett Canyon Seep, 14 North, and South Springs. No significant seasonal variations or trends in ground water quality at the Tibbett Canyon Seep or MW-1 are apparent.

Total iron concentrations range from below detection to 0.67 mg/l at the Tibbett Canyon Seep and from below detection to 1.97 mg/l in MW-1. Total iron concentrations exceed the SDW standard in four of thirteen samples collected from the Tibbett Canyon Seep and in five of thirteen samples collected from MW-1. Total manganese concentrations range from below detection to 0.10 mg/l at the Tibbett Canyon Seep and from below detection to 0.12 mg/l in MW-1. Total manganese concentrations exceed the SDW standard in one of thirteen samples collected from the Tibbett Canyon Seep and in three of thirteen samples collected from MW-1. One of

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the two samples from 14 South Spring contains 3.09 mg/l total iron. The one sample from 14 North Spring has slightly elevated total iron but no detectable manganese.

Fluoride concentrations in MW-1 exceed the SDW standard of 2.0 mg/l in eight of thirteen samples and zinc exceeds the SDW standard in one of thirteen samples. Fluoride concentrations in the Tibbett Canyon Seep exceed the SDW standard in two of thirteen samples. Fluoride concentration exceeds the SDW standard in one 14 South Spring sample. Mercury equals the PDW standard in one sample collected from MW-1. All other parameters fall under PDW and SDW limits.

### *Undifferentiated Straight Cliffs Formation*

In addition to the analyses of ground water from Wesses, Tibbett, and Drip Tank Springs, the U.S. Geological Survey sampled and analyzed ground water from four El Paso Natural Gas Company core holes in the spring of 1974 (BLM, 1976). The samples are from the Straight Cliffs Formation, but detailed information on lithology or stratigraphy is not available. TDS concentrations in water samples from the four core holes range from 866 to 1380 mg/l and averaged 1164 mg/l. Concentrations of fluoride exceed SDW standards in three of the four El Paso Natural Gas Company core holes and concentrations of sulfate and iron exceed SDW standards in one.

Andalex searched the USGS WATSTORE data base and located analyses of water samples taken from twenty exploratory holes drilled in the Smoky Hollow area. A summary of the chemical analyses is presented in Table VII-3 of the Smoky Hollow PAP. TDS concentrations in water samples from these drill holes were similar to water samples from the seeps, springs, and MW-1, ranging from 272 to 5920 mg/l and averaging 1045 mg/l.

For the combined El Paso and WATSTORE bore hole data, iron exceeds the SDW standard in only 4% of the bore hole samples as compared to 26% of the seep, spring, and well samples. Of the 24 bore hole samples, 2 exceeds the SDW standard for manganese, 8% as compared with 19% of the seep, spring, and well samples. The SDW standard for sulfate is exceeded in 21% of the bore hole samples, 5 of 24, and in 29% of the seep, spring, and well samples. The SDW standard for fluoride is exceeded in 29% of the bore hole samples but only in 23% of the seep, spring, and well samples.

### *Navajo Sandstone*

Water quality in the Navajo Sandstone ranges from fresh to slightly saline (Blanchard, 1986). In recharge areas the water type is calcium-magnesium-bicarbonate. In the Wahweap Bay area, it is generally sodium-calcium-sulfate-bicarbonate.

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No water samples have been collected from the Navajo aquifer within the Smoky Hollow area. In general, information on the chemical quality of water in the Navajo beneath the Kaiparowits Plateau is scarce, and what is available from records of oil-test holes is imprecise. Wells that tap the Navajo Sandstone in the nearby community of Big Water produce water containing about 500 mg/l to slightly over 1,000 mg/l of dissolved solids. Based on available data, including chemical analyses of base flows at the mouths of Wahweap, Warm, and Last Chance creeks prior to filling of Lake Powell, Price (1977a) assumed that the Navajo in the Kaiparowits Plateau, even where deeply buried beneath younger rocks, contains fresh water with local pockets of slightly saline water. The saline conditions are more likely where the aquifer is confined and the water can come in contact with the overlying Carmel Formation.

Repeated analyses of water from three water supply wells at Glen Canyon Recreation Area have found arsenic concentrations that exceed the PDW standard of 0.05 mg/l (Blanchard, 1986). However, these wells are several miles outside the CIA and on the south side of Wahweap Bay.

### *Ground Water Quantity*

From 1964 to 1974, 202 exploratory drill holes were drilled by a partnership of three large utility companies to evaluate the coal reserves and ground water resources of the southern Kaiparowits Plateau. Discontinuous perched saturated zones were encountered in and above the coal-bearing beds of the Straight Cliffs Formation. Correlation of perched zones between drill holes has not proven successful. When water was encountered: 1) the depth was noted, 2) an approximation of the discharge was made, usually in subjective terms such as "damp", "wet", "some water", "much water", and 3) drilling fluid was changed from air to mud. Several holes had water at multiple elevations, but the quantity of water at levels deeper than the first encounter was not noted, probably because drilling mud obscured it. Andalex drilled nine additional holes in 1990, using air only, to the bottom of the Red coal seam, the seam to be produced at the proposed Smoky Hollow Mine. Water, some dampness at the very bottom, was encountered in only one of those drill holes.

Water was more abundant in an area that wraps around the northwest plunging nose of the Smoky Mountain anticline and follows the Warm Creek and Last Chance synclines on either side. The wet area extends higher on the steeper east flank of the anticline than on the more gently dipping west flank. There are eight wet bore holes within or adjacent to the bottom of Smoky Hollow, and this topographic low appears to control recharge locally. Wesses and upper Warm Creek drainages undoubtedly contribute to local recharge in a similar manner but their impact is masked by the broader structural effect. Bore holes that were not in Smoky Hollow or in the structurally low areas were less likely to contain notable moisture. The conclusion is

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that ground water generally migrates from the anticlinal crest toward the Warm Creek and Last Chance synclines, with surface drainages contributing locally to ground water recharge.

In the bore holes, water was encountered in varying lithologies and strata of the Straight Cliffs Formation. Representative water samples were taken where the volume of inflow indicated potential beneficial use, mainly at bore holes located in the trough and on the east flank of the Warm Springs syncline. Andalex found analyses results on twenty of these samples through the WATSTORE data base. Water chemistries are dissimilar enough to suggest the inflows are from perched zones that are discontinuous and not directly interconnected.

Recharge to the perched zones is limited. Direct infiltration is limited by the high evapotranspiration and the low precipitation typical of the region. It is also restricted by low permeability strata in the Straight Cliffs Formation. The estimated potential ground water recharge for the Wahweap Creek basin, the 1670 square mile area between the Paria and Escalante Rivers that includes the CIA, is approximately 3,000 acre-feet per year. This represents an average of only 1 gpm/mi<sup>2</sup>. Regional recharge and discharge are estimated to be in a state of equilibrium (Blanchard, 1986).

Ground water discharge from seeps and springs of the Straight Cliffs Formation is small, but this small amount of water can be critical to the plant and animal communities that rely on it. The largest flow measured by Andalex is 60 l/minute (16 gpm) at Wesses Spring in October 1994. Based on data collected during the seep and spring surveys and subsequent quarterly monitoring, Andalex has estimated that seeps and springs account for only about 10% of total ground water discharge in the immediate vicinity of the proposed Smoky Hollow Mine. The remainder of the ground water is discharged via evapotranspiration or as underground flow to downgradient areas.

Several additional springs were added to the sampling program in February 1992 and November 1994. No flow was measurable at S-6 or S-8 during the November 1994 survey. Seepage from S-7 was estimated at 300 ml/minute (0.08 gpm). Estimated flow at Upper Wesses Seep was less than 0.5 gpm in 1994, and measured flow was 1,650 ml/minute (0.4 gpm) in March 1995.

Estimated annual recharge to and discharge from the Navajo aquifer in the Kaiparowits Plateau is between 8,300 and 16,900 acre-feet. In the Kaiparowits Plateau area, 76 springs that discharged from the Glen Canyon Group (including the Navajo Sandstone) were identified in 1965. Discharge was estimated to be 1,490 acre-feet per year. Lake Powell inundated 40 of these springs, which had accounted for 74% of the estimated discharge. The Navajo aquifer also discharges as baseflow

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to streams that flow into Glen Canyon, the majority of it into the Paria River. Evapotranspiration losses are estimated to be small (Blanchard, 1986).

Aquifers in the Navajo Sandstone have been tapped by several wells in areas near the CIA to supply water for domestic use and a fish hatchery. One well near Big Water reportedly can yield more than 1,000 gpm. Total withdrawal from these wells was approximately 500 acre-feet per year in 1976, most of it for the fish hatchery (BLM, 1976). In theory, the total amount of water that is recoverable from storage in the Navajo aquifer is 190 million acre-feet (Blanchard, 1986).

### IV. IDENTIFICATION OF HYDROLOGIC RESOURCES

Streams that drain the Andalex and 5M leases are of little value as water supplies because they are dry much of the year, flowing only in direct response to rainfall or snowmelt. When they do flow they often carry heavy loads of suspended and dissolved solids. Small impoundments have been constructed on a few streams to retain ephemeral runoff for stock watering. According to the BLM (1976) the lower reaches of the major drainages may be perennial during most years, but these are of little value because TDS concentrations exceed 3,000 mg/l (Price, 1979) and overall discharge rates are low.

Although the volume of water discharged is small, springs and seeps are important sources of drinking water for wildlife and livestock. The estimated consumption of water from seeps and springs by livestock in 1976, for the entire Kaiparowits Plateau, was less than 100 acre-feet per year. Seeps and springs provide intermittent flow for short distances in some stream channels. Except for Upper Wesses Seep in the Wahweap Formation, all identified springs and seeps within the CIA discharge from the Straight Cliffs Formation. Seeps within the Smoky Hollow permit area provide water seasonally for wildlife and sustain some vegetation.

From 1964 to 1974, ground water in the Straight Cliffs Formation was investigated for potential use in construction and operation of the then proposed Kaiparowits Power Project, a large coal fired power plant with associated coal mines and limestone quarry. The consulting engineering firm that did the investigation does not appear to have made an evaluation of the quantity or quality of ground water available, but applications for rights to the ground water were filed with the Utah State Engineer. These applications were concentrated within the previously described horseshoe shaped zone around the northwest plunging nose of the Smoky Mountain anticline.

Andalex installed monitoring well MW-1 in 1992, and a pump test produced water at one-half gpm from the Tibbett Canyon Member. Based on information from the earlier investigations and from well MW-1, Straight Cliffs Formation ground water within the CIA is not an exploitable hydrologic resource.

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Recharge for springs and seeps in the CIA probably originates in the small drainages or basins in the immediate vicinity. Low precipitation and high evapotranspiration limit the amount of water available for recharge. The low hydraulic conductivity of the rocks further limits recharge, although fractures may be locally important in recharge and ground water flow. Recharge to the deeper, Jurassic aquifers is from areas well beyond the boundaries of the CIA.

Wells supply water from the Jurassic Navajo and Entrada Formations in areas south and southwest of the CIA: around the town of Big Water, at the Glen Canyon National Recreation Area, and for a fish hatchery in lower Wahweap Creek. The Navajo aquifer is the anticipated source of the water to be used in operating the Smoky Hollow Mine. There are currently no springs discharging from these formations in the CIA or surrounding areas, but water from these formations does discharge as baseflow into Lake Powell.

### **V. MATERIAL DAMAGE CRITERIA - RELEVANT STANDARDS AGAINST WHICH PREDICTED IMPACTS CAN BE COMPARED.**

Standards of quality for waters of the State of Utah are set by the Utah Department of Environmental Quality (DEQ). To prevent pollution of waters in the state DEQ's Division of Water Quality has established Standards of Quality for Waters of the State, R317 (Utah Administrative Code). There are also primary (PDW) and secondary (SDW) drinking water standards set by DEQ's Division of Drinking Water in Rules for Public Drinking Water Systems, R309 (Utah Administrative Code). The drinking water standards are generally more stringent than the water quality standards when a parameter is listed in both, but many parameters are unique to one set of standards or the other. Standards from both sets of rules for Total Dissolved Solids (TDS), total iron, total manganese, and pH are shown in Tables 2 and 3. There is no water quality standard for total or dissolved manganese and no drinking water or water quality standard for Total Suspended Solids (TSS).

The level of protection or nondegradation for waters are also determined by the Utah Division of Water Quality. Standards usually vary between classifications. Water in Lake Powell is classified as:

- 1C - protected for domestic use with prior treatment,
- 2A - protected for recreational bathing (swimming)
- 2B - protected for recreational uses except bathing (swimming),
- 3B - protected for warm water aquatic life, and
- 4 - protected for agricultural uses.

The streams flowing into Lake Powell from the CIA are classified as:

- 2B - protected for recreational uses except bathing (swimming),



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- 3B - protected for warm water aquatic life, and
- 4 - protected for agricultural uses.

The water quality standards in Tables 2 and 3 are the most stringent that apply to this group of classifications.

Identified land uses within the proposed Smoky Hollow Mine permit area and LMPA are wildlife and livestock grazing and recreation, such as hunting, four-wheel driving, and gathering firewood. The CIA includes almost all of the BLM's Burning Hills Wilderness Study Area (WSA) and several thousand acres of the Wahweap WSA. Some of the Wahweap WSA is within the LMPA, but no acreage from either WSA was recommended for protection as wilderness by the BLM (BLM, 1991). The CIA includes a section of the Glen Canyon National Recreation Area, which surrounds Lake Powell. Recreational use in this area adjacent to the lake involves four-wheel driving and camping, and recreational use is heavier than in areas nearer the proposed Smoky Hollow mine.

The most likely post mining land uses in the CIA for the foreseeable future will continue to be recreation and livestock and wildlife grazing. The land and waters of the CIA should be maintained or restored to support these uses, and material damage criteria are based on that concept.

## VI. ESTIMATE OF PROBABLE FUTURE IMPACTS OF MINING ON THE HYDROLOGIC RESOURCES

Potential impacts of coal mining on the quality and quantity of surface and ground water flow include:

- o Contamination from acid- or toxic-forming materials.
- o Increased sediment yield from disturbed areas - suspended solids.
- o Dissolved solids.
- o Flooding or streamflow alteration.
- o Loss or reduction of discharge from springs.
- o Contamination of perched ground water.
- o Hydrocarbon contamination and noncoal waste.
- o Contamination of surface water from coal hauling operations.

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- o Contamination of the Navajo aquifer.
- o Drawdown of the Navajo aquifer.

### **Contamination from Acid- or Toxic-Forming Materials**

Material damage from acid- or toxic-forming materials is not probable.

Andalex collected core samples of the Red seam coal and of the strata immediately above and below from three drill holes. The drill holes are within the area proposed to be mined during first five years operation of the Smoky Hollow Mine, but Andalex also considers them as representative of the strata that will be encountered elsewhere in the mine. Composite samples of the Red seam coal, roof material from 0 to 10 feet above the coal seam, and floor material from 0 to 5 feet below the coal seam were analyzed from all three bore holes. In addition, roof material from one drill hole was categorized into three lithologic units, two shales separated by a thin coal rider, and each unit was analyzed separately. Five composite samples of exposed coal, overburden, and underburden were also collected from outcrops in the proposed disturbed area and analyzed. A total of seventeen samples, including fourteen composite samples, were analyzed for toxic- and acid-forming materials. Results of the chemical analyses are in Appendix VI-1 of the PAP.

Acid/base potentials were below the minimum acceptable level of -5 tons  $\text{CaCO}_3$ /1,000 tons in two coal samples (-5.43 and -10.8) and in one borehole floor sample (-14.1). Acid/base potentials for the remaining fourteen samples ranged from -3.13 up to 226 tons  $\text{CaCO}_3$ /1,000 tons, eleven being greater than 15 tons  $\text{CaCO}_3$ /1,000 tons.

Selenium levels in five samples exceeded the DOGM recommended maximum of 0.1 mg/kg. However, total digestion with hydrofluoric/perchloric acid, rather than hot water extraction as recommended by DOGM guidelines, was used on four of those five samples. As a result, total selenium, not just that available to plant life as determined by hot water extraction, was reported. These four samples were composites of roof or floor material recovered from borehole cores. It is possible that hot water extractable selenium concentrations are actually within DOGM guideline levels in these four samples. Hot water extraction was clearly used for the fifth sample, which is overburden from the outcrop exposure.

Sodium Adsorption Ratio (SAR) values exceed 15, the DOGM recommended maximum, in all six composite samples of roof or floor material; of the three lithologic samples from the roof material, SAR exceeds 15 in the rider coal and one of the shales. SAR levels in the three core samples of Red seam coal and in all five outcrop samples of both rock and coal are below 15.

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Andalex asserts that soluble cation concentrations in core samples of rock are lower than those in the native soils and that the high SAR values in the core samples of rock are not a reason for concern. Analyses of the core samples were done by one laboratory, analyses of the outcrop samples by another. The lab reports for the outcrop samples clearly state that water was used to extract the cations. The lab reports for the core samples do not indicate which cation extraction method was used, but Andalex contacted the laboratory that did the work, InterMountain Laboratories, Inc. in Wyoming, and was told that a water paste extraction was used. Two sets of soil analyses, found in Chapter II of the Smoky Hollow PAP, were done for Andalex. The set done in 1990 included cation extraction using ammonium acetate: cation concentrations and SAR values are usually, but not in all cases, higher than those from the core samples of rock. However cation extraction in the second set of soil samples, in 1992, was done using water: SAR values are generally much lower than in the core samples and the earlier soil samples. Based on this information, the assertion that SAR values are higher in the native soils than in the rock samples is not valid.

Storage of coal in the mine yard will be short-term. As coals are stockpiled, coals with low acid-base potential will become blended with more alkaline coals and the potentially acid-forming effects will be reduced. Coal fines that are washed from the stockpile will be stopped at the sediment pond and will be subject to the same testing, treatment, and disposal as the rest of the sediment. If precipitation produces acidic run-off from the coal stockpiles, it will tend to be neutralized by the alkaline nature of the mine yard substrate. Runoff will be collected at the sediment pond.

Coal is natural and abundant in the area, and coal from numerous outcrops in Smoky Hollow weathers and washes into the drainages as part of the natural geologic process. With construction of the sediment pond, the amount of coal fines in the natural drainage will be less than under naturally existing conditions.

No waste rock will be removed from the mine. Waste material generated during the mining operation, such as through installation of overcasts, will be permanently stored underground in cross-cuts or storage rooms. As this material will not be brought to the surface for storage or disposal, it will not be a factor in the reclamation of the minesite. The generally alkaline materials will serve to neutralize acid-forming materials that may be encountered. By storing the materials underground, oxidation of the material will be minimized.

Sampling of roof and floor rock will be conducted on a routine basis during the mining operation. Roof and floor samples, consisting of a minimum of one foot of rock material above and below the coal seam, will be collected from the mains and submains of the underground mine annually. They will be analyzed according to DOGM guidelines.

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### **Increased Sediment Yield from Disturbed Areas - Suspended Solids**

No material damage from increased or decreased sedimentation is anticipated.

Undisturbed drainage from Smoky Hollow and most of its tributaries above the mine site will be diverted beneath and discharged below the disturbed area via a properly sized bypass culvert. Runoff from the entire disturbed area and portions of the undisturbed area will be drained into a sedimentation pond.

During precipitation events in excess of the 10 year - 24 hour event, disturbed area drainage captured by the sedimentation pond and discharged as overflow into the main channel will have a lower sediment yield than the natural undisturbed drainage flow. The water discharged from the sedimentation pond, with lower suspended sediment, will mix with sediment-laden water in the stream channel, consequently minimizing the erosive effects of the sediment pond overflow. Due to the infrequency of precipitation in the region, the high net rate of evaporation, and the design of the sedimentation pond for total retention of the 10-year 24-hour storm, it is likely that only limited quantities of water will be discharged from the sedimentation pond. Excess water collected in the pond after runoff events may be released in a controlled manner by means of the decant device. To ensure that increased erosion does not change the downstream profile, the scouring effects of the released water will be monitored. If increased erosion occurs, the rate at which water is released will be reduced. The energy dissipator at the sedimentation pond outlet will further decrease potential scouring of the natural channel downstream from the disturbed area.

Andalex used the Universal Soil Loss Equation (USLE) to estimate the sediment yield from the proposed disturbed area upstream from the sedimentation pond. Before mining sediment yield is estimated to be 0.491 acre feet, and 1.872 acre feet during operation. The continually changing erodibility factor in the USLE makes it difficult to predict the sediment yield of the disturbed area during the construction and reclamation phases; however, Andalex will install the sedimentation pond during the first phase of construction and it will remain in place until the final phase of reclamation, so both construction- and reclamation-period sediment yields should be less than under natural conditions.

The higher precipitation in late summer months could produce a more rapid build-up of sediment in the pond. In the months following seasonal storms, water levels in the sediment pond may rise and result in discharge (decant) from the sediment pond. Characteristics of the stream channel below the disturbed area will be monitored during the life of the operation to evaluate hydrologic impacts on the stability of the natural channel.

### **Dissolved Solids**

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Baseline chemical quality of surface water in the region generally deteriorates in the downstream reaches of the streams in the region. Surface water in Warm, Last Chance, and Croton Creeks flows across the Tropic Shale before entering Lake Powell. TDS concentrations are naturally high in areas underlain by this marine shale.

No significant quantities of ground water are anticipated to be encountered during underground mining. Consequently, there should be no ground water discharged to the surface and TDS concentrations in surface waters should not be effected.

Soils to be used in construction of the surface facilities at the proposed Smoky Hollow Mine will be obtained primarily from the immediate area. High salinity soils will not be imported, eliminating one possible source of increased TDS in local surface water.

Water for the proposed underground mining activities will come from a water-supply well to be drilled into the Navajo Sandstone. TDS concentrations in water from the Navajo aquifer are expected to be significantly less than in ground water naturally occurring in the Straight Cliffs Formation. Seepage of the imported ground water from the mine workings into underlying rock should not increase TDS concentrations in the natural ground water. However, the imported water may pick up contaminants while being used in the mine and carry those contaminants with it as it seeps into the rock. Material damage is not probable because water in strata adjacent to the coal is a very limited resource and has little value, even to native plants or wildlife. Tibbett Canyon Seep is the only natural outlet of water from the strata beneath the coal within the CIA, and it is separated from the proposed mine by Warm Creek. Indications are that Tibbett Canyon Seep is recharged locally and will not be contaminated by the underground mine operations.

### **Flooding or Streamflow Alteration**

Runoff from the disturbed area will flow to the sedimentation pond. The pond has been designed to be geotechnically stable, which minimizes the potential for breaches that could cause downstream flooding. The sedimentation pond is also designed to completely contain the runoff from the 10-year 24-hour storm. If discharge to the undisturbed drainage does occur, the routing of flow through the sedimentation pond will reduce the peak flow and the downstream effects of flooding. Drainage captured by the sedimentation pond and discharged as overflow into the main channel during a 10-year 24-hour storm will have a lower sediment content than the natural undisturbed flow, but it will mix with sediment-laden water in the stream channel and the erosive effects of the sediment pond overflow will be minimized. On the other hand, by retaining excess sediment from the disturbed area in the

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sedimentation pond, the bottom elevations of the stream channel downstream from the disturbed area will not be artificially raised and the hydraulic capacity of the stream channel will not be altered.

Following reclamation, stream channels will be returned to a stable state. The reclamation channels have been designed to safely pass the peak flow resulting from the 100 year - 6 hour storm event, precluding flooding in the reclaimed areas.

Barriers and pillars will be left to prevent subsidence of the ephemeral stream channel in Smoky Hollow. Full extraction mining will be done under most of the other stream channels and subsidence of these small, ephemeral channels is a possibility. Surface cracks that result from subsidence tend to heal with time, but ephemeral stream flows may be intercepted until this healing process is completed. The following factors indicate that the impact of subsidence on ephemeral stream flow will be minimized:

1. Ephemeral streamflow in the area is sporadic, allowing significant periods of time for surface cracks to heal between flow events.
2. Ephemeral streamflow typically carries a high sediment load that will fill cracks. As the cracks fill, the potential for interception of streamflow will be minimized.
3. Depressions created by subsidence are typically broad enough that changes in slope do not cause ponding.

### **Loss or Reduction of Discharge from Springs and Seeps**

Draining of perched ground water zones by subsidence cracks is a potential impact of the proposed underground mine. Perched ground water zones may also be intercepted directly by the underground mine. These perched zones are generally lenticular and are not hydraulically connected to each other or to a regional aquifer, so dewatering some of these perched zones will have minimal effect on seeps and springs and on the overall hydrologic balance.

Perched ground water zones in the Straight Cliffs and Wahweap Formations have low recharge capacity due to the low precipitation and high evapotranspiration rates of the area. Impermeable strata impede movement of water into or out of the perched zones. Similar perched zones encountered by coal mines in central Utah contain limited quantities of water and usually dewater rapidly.

The loss of discharge from the seeps would produce a minimal impact on the hydrologic balance because of their low yield and apparently discontinuous discharge.

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The area affected by a loss of flow would not extend beyond the area immediately around the seeps.

Perched ground water zones feed the five seeps identified within the Smoky Hollow permit area. None of those seeps has produced a measurable flow during the baseline monitoring period, although some water has been seen at three. If subsidence cracks were to intersect perched water zones discharging at the seeps, the water could be diverted to discharge either at another surface location or into the mine. Water diverted into the mine would mix with the water being used in the mining operation and no discharge from the mine would be expected. Bentonite clay is common in the Straight Cliffs Formation and it is possible the clay would swell, seal the cracks, and stop or reduce any downward flow of water. The seeps are located near the top of the plateau, so subsidence should be uniform and the formation of subsidence cracks is doubtful.

It is not likely that seeps and springs located outside the permit area will be affected by the proposed Smoky Hollow Mine because they are outside the projected zone of subsidence and are not hydraulically connected to the perched zones within the Smoky Hollow permit area. The closest spring to the permit area is Needle Eye Water, which is located more than 2 miles outside the projected zone of subsidence.

The Tibbett Canyon Member appears to contain saturated zones beneath much of the permit and adjacent areas. However, it is separated from the Red coal seam by approximately 150 feet of thick, fairly impermeable mudstone beds. Ground water in the Tibbett Canyon Member should not be affected by the mining process because of this barrier. Recharge to the Tibbett Canyon Member from above, in the vicinity of the mine area, is probably minimal due to the thick sequence of mudstone, low precipitation rate, and high evapotranspiration rate.

### Contamination of Perched Ground Water

There is no foreseen pathway by which perched waters above the coal seams can be contaminated by the anticipated mining operations. All planned facilities will be at the level of the coal or lower.

The probability of contaminating perched water below the surface facilities is low because of the low hydraulic conductivity of the strata, the small size of the disturbed area, and surface drainage controls for the disturbed area.

Downward flow of water from the underground workings into underlying strata is a possible route for contamination. Water will be sprayed on the working faces during mining. Excess water will flow across the mine floor and collect in underground sumps for reuse. Such water is usually conditioned with surfactants, which are potential ground water contaminants. If there are contaminants in the rock

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dust used for dust control in the mine, the water may also pick those up. The low hydraulic conductivity of the rocks below the coal will limit the infiltration of this water to underlying strata. The Calico Sandstone and Tibbett Canyon Member are separated from the Red coal seam by thick, fairly impermeable mudstone beds. The anticipated dryness of the mine and the expense of supplying water for the operation will be factors in limiting the volume of water allowed to stand in underground sumps.

After cessation of mining and reclamation of the disturbed surface area, it is possible that the underground workings will fill with water, but the low recharge rate and low hydraulic conductivity of the rocks make it unlikely.

### **Hydrocarbon Contamination and Noncoal Waste.**

The probable extent of contamination caused by diesel and oil spillage is expected to be small. Storage tanks will be located above ground within impermeable concrete containment structures. Leakage from the tanks will be readily detected and contained and the tanks repaired. Spillage during filling of storage or vehicle tanks will be minimized to avoid loss of an economically valuable product. As a last line of defense, accidental spillage from anywhere within the minesite would be caught and contained within the sediment pond in accordance with the Spill Prevention Control and Countermeasure Plan (SPCC) located in Appendix V-7 of the Smoky Hollow PAP.

Noncoal mine wastes will be controlled by placing or storing them at the mine material storage yard. Permanent disposal will be at a state-approved waste disposal site. No noncoal waste will be permanently disposed of within the permit area.

### **Contamination of Surface Water from Coal Hauling Operations**

Coal will be hauled from the mine portal area via covered highway trucks with mechanically sealed discharge gates. If a spill occurred it would be cleaned up as soon and as completely as practical. Residual coal left after cleanup of the spill may wash into local streams during a runoff event and cause a temporary increase in total suspended solids and turbidity. Hazardous or toxic elements have been found in some coal samples, but coal has weathered from the outcrops in this area for millions of years and occurs naturally in the stream sediments. Due to the probable infrequency of spillage, the relatively small volume of coal that would be involved in a single incident, and the rapidity with which the spill will normally be remedied, the probable impact of coal spillage on the hydrologic system should be insignificant.

A qualitative assessment of impacts from the proposed mining operations reveals that there is a low potential for significant increases in Total Suspended Solids (TSS) levels in local streams due to fugitive dust from coal haulage and surface-



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facility operation. The expected concentration of air particulates (TSP, total suspended particulates) from the proposed mining operation have been determined using EPA approved air quality modelling programs. These computer model runs incorporated all potential TSP sources associated with the proposed facility, including the coal pile, material transfers, disturbed areas including roads, access road traffic, and the truck loading facility.

### **Contamination of the Navajo Aquifer**

The Tropic Shale underlies the Straight Cliffs Formation. It is 600 to 700 feet thick in the Smoky Hollow area and has very low hydraulic conductivity. In addition to the Tropic Shale there is a substantial thickness of Dakota, Morrison, Cow Springs, Entrada, and Caramel strata separating the coal bearing John Henry Member from the Navajo Sandstone. Fracturing of the mine floor, from redistribution of stresses to pillars and barriers, will not extend more than a few feet downward. There is no foreseeable path for contamination to reach the Navajo aquifer from the coal mine.

### **Drawdown of the Navajo Aquifer**

Current usage for domestic and irrigation purposes from the Navajo, within the Kaiparowits Plateau, is about 1,700 ac-ft per year (1,050 gpm). Withdrawal from the wells around Big Water and Wahweap was approximately 500 acre-feet per year in 1976. Under current recharge and discharge conditions, the ground water within the Kaiparowits plateau is considered to be in a state of equilibrium. Recharge is estimated to be 8,300 to 16,900 acre-feet per year. Total estimated recoverable water from the Navajo (at an estimated yield of 10%) is 140 million acre-feet (Blanchard, 1986). Blanchard calculated the effects of withdrawing 40,000 and 20,000 acre-feet per year from wells in the same general area as the proposed Smoky Hollow Mine. For both cases, the results indicated that water would be removed from storage rather than diverted from natural recharge and that drawdown would be several hundred feet in the vicinity of the wells. By comparison, calculations for withdrawal of 400 acre-feet per year indicate maximum drawdown will be less than 20 feet, even in the immediate vicinity of the well. Withdrawal of 400 acre-feet per year will not adversely affect the state of equilibrium of the Navajo aquifer by causing large drawdown of the potentiometric surface and removing large volumes of water from storage.

## **VII. MATERIAL DAMAGE DETERMINATION**

Streams draining the CIA already exceed all water quality criteria for Total Dissolved Solids (TDS) by the time they reach Lake Powell. In the lower reaches of Last Chance and Wahweap Creeks, concentrations of arsenic, cadmium, lead, manganese, and selenium frequently exceed EPA primary drinking water (PDW)

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standards (USGS, 1979). Similar conditions are assumed for Warm Creek. TDS concentrations in samples taken by Andalex from the ephemeral drainages within the proposed Smoky Hollow permit area range from 200 to over 2,000 mg/l. Chemical parameters in these water samples show a wide spatial and temporal variation. Total iron and manganese frequently exceeded secondary drinking water (SDW) standards and sulfate, selenium, and nitrate SDW standards were also exceeded in some samples. Total suspended solids concentrations are usually directly proportional to discharge rates, and tend to be high in streams in this region due to the sporadic, rapid, short duration nature of the runoff and to the erodibility of the surface.

Information in the Smoky Hollow PAP indicates drainage from the disturbed area will report to a sedimentation pond, which is designed to totally contain runoff from the projected 10 year - 24 hour precipitation event. Runoff in excess of that amount will pass through the pond before being discharged to the natural drainage. No water will be discharged from the underground mine into the pond or the natural drainages. Operation of the Smoky Hollow Mine should not effect either the chemical or sediment load of the streams.

TDS concentrations in ground water from seeps and springs within the CIA range from 158 to 2,668 mg/l. Similar TDS concentrations are found in ground water samples from bore holes within the CIA, except the maximum is 5,920 mg/l. Total iron and manganese concentrations frequently exceed SDW standards.

Springs and seeps discharge from local, usually perched and isolated aquifers, and most discharge from strata that lie above the coal beds. Perched aquifers above the coal seams may be drained where subsidence cracks or mining intercept them. Flows from five seeps that are above areas of planned mining may be relocated, reduced, or even dried completely because of subsidence. Other springs and seeps outside the permit areas should not be affected by the mine operation.

The Tibbett Canyon Member beneath the coal seam is not a regional aquifer and does not yield significant amounts of water to seeps, springs, or wells. It is separated from the coal seam by approximately 150 feet of low permeability rock. Mining should not affect either the quality or quantity of water in the Tibbett Canyon Member, where it occurs.

Ground water in the Navajo aquifer is separated from the coal by a 600 to 700 feet of almost impermeable Tropic Shale, and another several hundred feet of other low permeability rocks. Direct impacts to the Navajo aquifer from the mining will not occur. Up to 400 acre-feet of water will be withdrawn yearly for operation of the Smoky Hollow Mine, but this volume of withdrawal should not take water from storage or cause significant drawdown of the potentiometric surface. Withdrawing

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400 acre-feet per year may reduce the baseflow discharge into Lake Powell by a similar amount.

### VIII. STATEMENT OF FINDINGS

No potential for material damage outside the permit area has been found. No cumulative impacts have been identified. During the initial 5-year term of the Smoky Hollow Mine permit, it is unlikely that the other anticipated operations will produce any impacts of any kind.

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